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The Effect on Electrophysiology Pattern After Electronic Near Task

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***Abstract*—When performing near tasks, the visual system is actively engaged, requiring varying degrees of effort from the ocular muscles depending on the individual. As the eye focuses on a nearby object, the ciliary muscles contract, causing the crystalline lens to thicken and become more rounded compared to when focusing at a distance. Increased exposure to digital screens places significant visual stress on the eyes, raising the risk of ocular abnormalities such as digital eye strain and myopia progression. This study aimed to compare electrophysiological changes after near work in subjects with different refractive errors, without refractive correction. Four young adults (aged 18–26) from UiTM Puncak Alam, Malaysia, participated. Multifocal electroretinography (mfERG) recordings were taken before and after 10 minutes of electronic near work. Results showed no significant differences in amplitude or implicit time between pre-exposure data (with and without correction) for N1, P1, and N2 waveforms across refractive groups. Similarly, no significant differences were observed between pre- and post-exposure data in implicit time or amplitude for Eyes 3 and 4 when recorded with correction. Additionally, no significant mean differences were found in implicit time across all subjects (Eyes 1–4) for N1, P1, and N2. However, Eye 2 exhibited a significant mean difference in N1 amplitude ($p=0.047$), and Eye 4 showed a significant difference in N2 amplitude ($p=0.033$). In conclusion, this study found no significant electrophysiological changes in retinal response before and after digital near task exposure, as measured by mfERG, in both corrected and uncorrected eyes. The few observed amplitude differences suggest individual variability, but overall, near work did not substantially alter retinal electrophysiology in this sample.**

***Keywords*—Electrophysiology, Multifocal electroretinography (mfERG), Digital eye strain.**

I. INTRODUCTION

When an individual performs near tasks, the visual system is engaged. The effort exerted by the ocular muscles varies depending on the person. When focusing on a nearby object, the crystalline lens changes shape with the assistance of the ciliary muscles, becoming rounder and thicker compared to when the eye focuses on distant objects [1]. This mechanism, which requires effort from the eye, is known as the accommodation system. However, prolonged near work has significantly impacted global vision health, with a sharp rise in refractive errors observed during the COVID-19 pandemic due to increased screen time [2]. As governments implemented preventive measures such as standard operating procedures (SOPs) emphasizing social isolation, people were compelled to engage more in near tasks, particularly digital near work [3, 4].

The introduction of work-from-home policies and online distance learning protocols by governments led to a surge in household purchases of electronic devices such as desktops, laptops, and smartphones to facilitate daily activities. As previously mentioned, when the eyes focus on near tasks, the crystalline lens accommodates by changing shape, adjusting the focal distance so that the perceived image is properly focused on the retina [5]. While electronic devices offer adjustable screen brightness for user comfort, prolonged exposure to screen luminance may negatively affect visual function. As light reaches the retina, it initiates a cascade of reactions within the retinal layers, eventually sending visual signals to the brain [6].

As digital screen exposure rises, whether for work or leisure, the eyes experience heightened strain,

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elevating the likelihood of vision-related issues like digital eye [4] and myopia development [7]. Many studies have looked at how eye disorders and refractive errors affect vision, but few have examined how screen use impacts retinal function, especially before and after visual stress. Most research uses mfERG only for baseline measurements or retinal disease, without testing changes after digital device exposure. More studies comparing pre- and post-screen exposure data are needed.

II. LITERATURE REVIEW

The retina serves as the neural interface for visual signal transduction, with electrophysiological techniques like full-field electroretinography (ffERG), multifocal ERG (mfERG), and pattern ERG (pERG) providing critical insights into its functional status. Recent studies have advanced our understanding of retinal electrophysiology, particularly in neurodegenerative diseases, inherited retinal disorders, and the effects of novel therapeutic interventions.

Multifocal ERG (mfERG) provides an objective method to evaluate retinal dysfunction associated with digital eye strain by measuring localized electrical responses in the macula. Prolonged screen exposure appears to cause measurable changes in mfERG parameters, particularly reduced response amplitudes and delayed implicit times in central retinal regions, likely due to photoreceptor stress from intense focus and blue light exposure. These electrophysiological alterations correlate with common symptoms like visual fatigue and blurred vision, suggesting mfERG could help distinguish true retinal strain from other causes of eye discomfort. While still being researched, mfERG shows potential as a diagnostic tool to assess screen-related visual fatigue and monitor the effectiveness of interventions like protective filters or screen time modifications, offering advantages over subjective symptom reports alone [8]. Multifocal electroretinogram recordings can be compromised by various factors. Technical factors include poor fixation, excessive eye movements, orbicularis oculi contraction, cervical muscle tension, corneal electrode opacity, electrode displacement, lens misalignment, improper viewing distance in high refractive error cases, incorrect eye-level alignment with the screen center, 60 Hz electrical noise, electromagnetic interference, and high impedance. Additional influencing factors include optical characteristics and anatomical variations [9].

Multifocal electroretinograms (mfERGs) can be reliably recorded in most well-equipped clinical visual electrophysiology laboratories. They are useful for detecting localized retinal abnormalities in the macula, paramacular region, or discrete peripheral areas that may not be apparent during a standard clinical examination. These tests can aid in diagnosing conditions such as subtle age-related macular degeneration, macular holes, hydroxychloroquine toxicity, retinitis pigmentosa, branch retinal artery occlusion, fundus flavimaculatus, Stargardt's disease, and acute idiopathic blind spot enlargement [10]. Objective measures of visual function play a key role in diagnosing and monitoring complex ocular conditions. In early hydroxychloroquine maculopathy, color vision and visual field testing may be less sensitive than electrophysiological assessments [11].

The multifocal electroretinogram (ERG) can detect subclinical visual field defects in glaucoma and other optic neuropathies, often before abnormalities appear on automated perimetry. Past studies were done using multifocal electroretinogram (mfERG) to investigate the changes in two groups such as control and case group. mfERG is a golden instrument with various functions specifically to assess the responses that happen in the retinal layer. Lai *et al.* [12] noted that the mfERG can identify a reduction in the initial negative deflection N1 and positive deflection P1 response amplitudes from the central macula when comparing subjects with mild or moderate cataract to those with very mild cataract. Lyons *et al.* [13] found that mfERG effectively detected retinal toxicity in patients taking Plaquenil, particularly in those with a cumulative dose exceeding 1250 g, where abnormalities were observed in 26 out of 64 eyes. They concluded that mfERG is a sensitive tool for assessing ocular toxicity, especially when analyzing ring ratios. The author agrees that the mfERG is sensitive enough to provide information about ocular toxicity through the ring ratios.

An mfERG study on keratoconus patients discovered that there was no significant difference of implicit times for all waveform when patients wore the scleral lens during the tests [14]. The authors noted a decrease in P1 amplitude, though the reduction was not statistically significant and closely resembled findings in subjects without keratoconus. Based on this observation, they concluded that irregular corneal surfaces do not significantly impair retinal function.

Refractive error like myopia has always been the concern for many studies and it was observed that the high incidence of myopia in Asia (60%) was hugely linked with the prolonged duration of screentime for education purpose [15]. Myopia is a condition where the axial length is too long for its optical power [16] in every meridian (axial, vertical and horizontal) compared to emmetropic eyes [17]. The mfERG results are also affected by changes of refractive status and the axial length given that the patient is normal [12].

For myopes, studies were conducted to focus more on the changes of mfERG waveforms [18] found that the implicit time of P1 waveform in optically corrected myopes in comparison to emmetropes was significantly longer by 1.3 - 3.1 ms. MfERG responses were not attributable to the anatomical changes of myopic eye since only 15% of the implicit time of total variance was contributed by the axial length while refractive error contributed 27% of the longer implicit time. Therefore, the optical factor was considered important during the study due to the different refractive status of the subjects. This was observed the

specifically on the changes in amplitude rather than the implicit time of the waveforms, specifically the P1 and N1. Sachidanandam *et al.* [19] found that the amplitude of P1 and N1 were significantly decreased in all five rings, especially the central ring when the axial length increases. They and colleagues categorized all subjects based on their axial length. Their study revealed distinct mfERG patterns among groups with varying axial lengths. Specifically, they observed that with each millimeter increase in axial length, the reduction in P1 and N1 amplitudes became more pronounced in the central retinal regions, particularly the fovea and parafovea.

Despite focusing on different factors, both the former and latter authors somehow supported the earlier study where the authors observed the reduction of amplitudes and delayed implicit times as the refractive errors increase [20]. Kader [21] conducted a study that has included both the optical and anatomical factors. He found that, for subjects with optically corrected medium myopia and high myopia, there were significant reduction of both the amplitude and implicit time of P1 peak given that they have no retinal degeneration. Finally, he concluded that there are a few factors that may have contributed to the reduction of amplitude and implicit time which includes optical, electrical, and retinal factors.

Finally, a study that compares emmetropes and myopes children and adult was conducted by Ho *et al.* [22]. The authors did not mention the specific factors that were included however, he mentioned that both the myopic groups wore optical correction during the study and stated that retinal differences were considered. The study was conducted between emmetropes and myopes among children and adult using the global flash mfERG. The measurement was taken at two levels of contrasts which were 49% and 96% and it found that myopic children showed a significant reduction in direct component (DC) response (P1) of central macula at 96% contrast, while there were no changes observed from the induced component (IC) response when compared with myopic adult where the IC amplitude (N3) was significantly reduced for paracentral area at 49% contrast. The Direct Component (DC) resembles traditional mfERG responses, whereas the Induced Component (IC) reflects the response modulation caused by the global flash following the preceding local flash [23]. In comparison by Ho *et al.* [22] earlier, he found that the inner retinal function was reduced in myopic adult which led to the findings compared to the children myopes.

A concern has arisen due to higher demand of electronic devices and its association to the progression of refractive error with the easiest example, myopia. Therefore, this study will be conducted to observe the changes in the electrophysiological pattern of the retina when exposed to visual stimuli specifically among young adults with different refractive status.

III. RESEARCH METHODOLOGY

This study employed a cross-sectional intervention design to observe electrophysiological changes in the retina before and after exposure to a digital near task. Participants were recruited from among young adults at UiTM Selangor, Puncak Alam Campus through a combination of random selection and convenience sampling methods. Participants were required to be young adults between 18 and 26 years of age and needed to demonstrate best-corrected visual acuity of 6/6. Eligible participants exhibited refractive errors within specific parameters, including hyperopia ranging from +0.75 to +3.00 diopters or myopia between -0.50 and -4.00 diopters. Additionally, participants were required to have no history of any ocular or binocular vision disorders.

Participants were excluded from the study if they presented with any systemic diseases or were currently taking medications for systemic conditions. These exclusion criteria helped ensure that the study population represented individuals without complicating health factors that might influence the visual parameters under investigation.

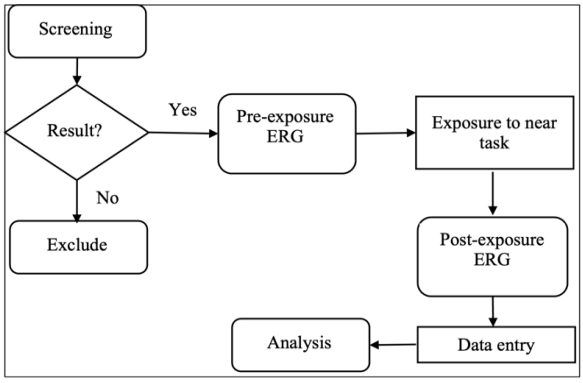

Fig. 1. Flowchart of research procedure.

Initially, participants underwent a screening procedure that included history taking and visual acuity testing. Those who met the eligibility criteria proceeded to sign a consent form and were given a detailed briefing about the study procedures. Participants who did not meet the screening criteria were excluded from the study (Figure 1). Eligible participants, referred to as Eye 1 through Eye 4, then proceeded to the pre-exposure electroretinography (ERG) recording. This procedure was conducted both without refractive correction (for all participants: Eye 1 to Eye 4) and with refractive correction (for Eye 3 and Eye 4 only).

Following the initial ERG recording, participants were exposed to a near task involving a digital reading activity displayed on an electronic device set to its highest brightness level. This task was carried out for 10 minutes at a working distance of approximately 10 to 15 centimeters. Immediately after the task, a post-exposure ERG recording was performed using the same method as the pre-exposure session.

This study received ethical approval from the UiTM Research Ethics Committee, and all participants

provided written informed consent prior to their involvement.

For the experimental procedure, the testing was conducted on one eye (left eye) for every subject, hence, the subjects were referred to as Eye 1 and so on. For the preparation of electrodes placement, especially the electrode insertion, the left eye for every subject was instilled with 0.5% proparacaine hydrochloride (Alcaine). Then a non-corneal electrode (HK loop type) was inserted into the lower conjunctival sac of the prepped eye. For the ground electrode, it was attached on the earlobe while the reference electrode was attached on the forehead.

The first recording was for the pre-exposure data. This was conducted after the subject was seated comfortably in front of the screen. For subjects that came with spectacle correction, the recording was done twice for two conditions (without correction and with correction). For subjects with no spectacle correction, the recording was done once. Each recording was done for approximately four to six minutes.

Next, the subjects were instructed to read the near task that was provided to them. The tasks were done using their own smartphone to allow a more natural and comfortable near task activity. However, the setting for the digital printed task was standardised for all subjects. The digital reading task was in N5 font size, and the brightness of their smartphone has been set on 100% brightness. The working distance was approximately 10 to 15 centimetres. All subjects had performed the task for 10 minutes before the next step.

Lastly, for post-exposure recording, it was done the same as the pre-exposure recording and took approximately four to six minutes. The whole procedure took less than an hour to be completed. The parameters of concern were implicit time and amplitude for all waveforms. These parameters were measured using the mfERG following the latest protocol by International Society for Clinical Electrophysiology of Vision (ISCEV). The mfERG stimuli used was the 61 elements. Both parameters were measured simultaneously in a single recording. To ensure the recording obtained were reliable, all the subjects were reminded to fixate on the central target throughout the procedure [24].

In this research, the data entry and statistical analysis have been done using the IBM Statistical Package for Social Sciences (SPSS) software version 28.0. The test used was the descriptive analysis consisting Paired T-test for parametric data after normality has been assumed using the Shapiro-Wilk normality test.

IV. RESULTS AND DISCUSSIONS

A total of five young adults from Puncak Alam participated in the study. However, due to a technical issue with the main computer, the data for subject number five could not be retrieved. Consequently, only four participants were included in the final data analysis. The final group consisted of two males and two females.

Subject one (Eye 1) was a male emmetrope (PL) who did not use any refractive correction. Subject two (Eye 2) was a male with simple hyperopia (+0.75 DS) and did not use any refractive correction. Subject three (Eye 3) was a female with corrected simple myopia (-0.50 DS), while subject four (Eye 4) was a female with corrected compound myopic astigmatism (-3.50/-1.50 × 15).

In this study, since the parameters of interest were the amplitude and the implicit time for N1 waveform, P1 waveform and N2 waveform, the data were analysed using the parametric test for descriptive analysis. The data presentation includes the mean and standard deviation for the parametric test and not median and interquartile range (IQR).

A. Comparison of mfERG Pre-Exposure Measurements of Subjects With Different Refractive Errors Without and With Refractive Correction.

The study was conducted for two types of refractive errors in two conditions. For each refractive error group, the parameters were compared for two conditions which were without correction and with correction (see Table I and Table II).

B. Comparison of mfERG Measurements of Subjects With Different Refractive Errors With Full Refractive Correction.

The mean difference was observed for all waveforms N1, P1 and N2 for pre- and post- exposure data which was acquired when the subjects did not use any correction (see Table III and Table IV).

C. Comparison of Changes After Near Work Among Subjects With Different Refractive Errors Without Correction.

All four subjects were included for this study. Firstly, there were no significant mean differences between the pre-exposure implicit time and the post-exposure implicit time among all subjects (Eye 1, Eye 2, Eye 3, and Eye 4) for N1, P1 and N2 (see Table V, Table VI, Table VII and Table VIII).

Table I. The difference of implicit time and amplitude for pre-exposure without and with correction for Eye3.

	Variables	**Without correction Mean (SD)**	**With correction Mean (SD)**	**Mean difference (95% CI)**	**t-stats (df)**	***p*-value**
N1	Implicit time Amplitude	28.34 (2.49) -466.40 (49.29)	22.72 (12.82) -311.20 (305.52)	5.62 (-12.01, 23.25) -155.20(-449.32,138.92)	0.89 (4) -1.47 (4)	0.426 0.217
P1	Implicit time Amplitude	48.06 (3.21) 961.80 (653.72)	47.78 (2.41) 730.80 (527.89)	0.28 (-1.24,1.80) 231.00 (-4.13,466.13)	0.51 (4) 2.73 (4)	0.636 0.053
N2	Implicit time Amplitude	65.54 (5.46) -847.80 (403.18)	71.70 (9.09) -767.60 (285.23)	-6.16 (-19.16,6.84) -80.20 (-262.14, 101.74)	-1.32 (4) -1.22 (4)	0.257 0.288

Table II. The difference of implicit time and amplitude for pre-exposure without and with correction for Eye4.

	Variables	**Without correction Mean (SD)**	**With correction Mean (SD)**	**Mean difference (95% CI)**	**t-stats (df)**	***p*-value**
N1	Implicit time Amplitude	26.42 (4.39) -208.90 (190.35)	28.48 (2.93) -270.10 (214.40)	-2.06 (-10.77, 6.65) 61.20 (-96.15, 218.55)	-0.66 (4) 1.08 (4)	0.547 0.341
P1	Implicit time Amplitude	48.08 (3.58) 566.60 (137.04)	48.64 (5.41) 564.60 (277.55)	-0.56 (-2.91, 1.79) 2.00 (-300.93, 304.93)	-0.66 (4) 0.02 (4)	0.544 0.986
N2	Implicit time Amplitude	72.44 (8.59) -590.60 (315.60)	59.32 (35.28) -405.00 (310.56)	13.12 (-40.54, 66.78) -185.60 (-454.76, 86.56)	0.68(4) -1.92 (4)	0.534 0.128

Table III. The changes of implicit time and amplitude pre- and post- exposure with correction for Eye3.

	Variables	**Pre- exposure Mean (SD)**	**Post-exposure Mean (SD)**	**Mean difference (95% CI)**	**t-stats (df)**	***p*-value**
N1	Implicit time Amplitude	27.72 (12.81) -311.20 (305.52)	28.80 (2.22) -393.88 (481.42)	-6.08 (-23.64, 11.48) 82.68 (-217.09, 382.45)	-0.96 (4) 0.77 (4)	0.391 0.487
P1	Implicit time Amplitude	47.78 (2.41) 730.80 (527.89)	48.74 (2.02) 615.60 (325.60)	-0.96 (-1.94, 0.02) 115.20 (-441.27, 671.67)	-2.72 (4) 0.58 (4)	0.053 0.596
N2	Implicit time Amplitude	71.70 (9.09) -767.60 (285.23)	55.22 (32.73) -405.00 (469.35)	16.48 (-20.71, 53.67) -362.60 (-734.64, 9.44)	1.23 (4) -2.71 (4)	0.286 0.054

Table IV. The changes of implicit time and amplitude pre- and post- exposure with correction for Eye4.

	Variables	**Pre-exposure Mean (SD)**	**Post-exposure Mean (SD)**	**Mean difference (95% CI)**	**t-stats (df)**	***p*-value**
N1	Implicit time Amplitude	28.48 (2.93) -270.10 (214.40)	29.16 (0.75) -383.80 (172.03)	-0.68 (-4.62, 3.26) 113.70(-82.59, 309.99)	-0.48 (4) 1.61 (4)	0.658 0.183
P1	Implicit time Amplitude	48.64(5.41) 564.60 (277.55)	47.92 (5.05) 581.40 (382.83)	0.72 (-0.47, 1.91) -16.80 (-205.86, 172.26)	1.68 (4) -0.25 (4)	0.169 0.817
N2	Implicit time Amplitude	59.32 (35.28) -405.00 (310.56)	67.80 (9.33) -428.20 (157.32)	-8.48 (-53.49, 36.53) 23.20 (-262.39, 308.79)	-0.52 (4) 0.23 (4)	0.629 0.833

Table V. The changes of implicit time and amplitude pre- and post- exposure without correction for Eye 1.

	Variables	**Pre-exposure Mean (SD)**	**Post-exposure Mean (SD)**	**Mean difference (95% CI)**	**t-stats (df)**	***p*-value**
N1	Implicit time Amplitude	29.36 (2.66) -536.20 (435.82)	29.16 (0.84) -467.80 (251.22)	0.20 (-2.30, 2.70) -68.40 (-451.89, 315.09)	0.22 (4) -0.50 (4)	0.835 0.646
P1	Implicit time Amplitude	48.68 (3.11) 763.40 (237.06)	48.40 (4.22) 722.20 (275.29)	0.28 (-2.56, 3.12) 41.20 (-47.79, 130.19)	0.27 (4) 1.29 (4)	0.798 0.268
N2	Implicit time Amplitude	68.76 (7.75) -555.80 (141.71)	65.84 (3.65) -523.20 (213.18)	2.92 (-8.78, 14.62) -32.60 (-247.46, 182.26)	0.69 (4) -0.42 (4)	0.526 0.695

Table VI. The changes of implicit time and amplitude pre- and post- exposure without correction for Eye 2.

	Variables	Without correction Mean (SD)	With correction Mean (SD)	Mean difference (95% CI)	t-stats (df)	*p*-value
N1	Implicit time Amplitude	29.82 (1.43) -686.80 (778.17)	24.96 (14.08) -509.20 (689.63)	4.86 (-11.90, 21.62) -177.60 (-351.95, -3.25)	0.81 (4) -2.83 (4)	0.466 0.047
P1	Implicit time Amplitude	49.36 (4.65) 795.60 (529.29)	48.46 (4.35) 816.40 (530.27)	0.90 (-0.39, 2.19) -20.80 (-104.75, 63.15)	1.94 (4) -0.69 (4)	0.124 0.529
N2	Implicit time Amplitude	70.96 (10.91) -527.60 (128.04)	66.02 (3.53) -587.40 (142.71)	0.94 (-8.78, 18.66) 59.80 (-146.65, 266.25)	1.00 (4) 0.80 (4)	0.374 0.466

Table VII. The changes of implicit time and amplitude pre- and post- exposure without correction for Eye 3.

	Variables	Without correction Mean (SD)	With correction Mean (SD)	Mean difference (95% CI)	t-stats (df)	*p*-value
N1	Implicit time Amplitude	28.34 (2.49) -466.40 (491.29)	30.36 (2.87) -176.60 (172.60)	-2.02 (-8.08, 4.04) -289.80 (-1070.02, 490.42)	-0.93(4) -1.03(4)	0.407 0.361
P1	Implicit time Amplitude	48.06 (3.21) 961.80 (653.72)	49.60 (4.43) 712.60 (442.41)	-1.54 (-3.83, 0.75) 249.20 (-191.78, 690.18)	-1.87(4) 1.57(4)	0.135 0.192
N2	Implicit time Amplitude	65.54 (5.46) -847.80 (403.18)	56.18 (33.36) -316.96 (295.50)	9.36 (-37.84, 56.56) -530.84 (-1205.83, 144.16)	0.55(4) -2.18(4)	0.611 0.094

Table VIII. The changes of implicit time and amplitude pre- and post- exposure without correction for Eye 4.

	Variables	Without correction Mean (SD)	With correction Mean (SD)	Mean difference (95% CI)	t-stats (df)	*p*-value
N1	Implicit time Amplitude	26.42 (4.39) -208.90 (190.35)	28.28 (1.98) -314.64 (320.11)	-1.86 (-5.70, 1.98) 105.74 (-95.07, 306.55)	-1.34(4) 1.46(4)	0.250 0.218
P1	Implicit time Amplitude	48.08 (3.58) 566.60 (137.04)	48.80 (4.52) 538.00 (316.97)	-0.72 (-1.90, 0.46) 28.60 (-334.34, 391.54)	-1.69(4) 0.219(4)	0.166 0.838
N2	Implicit time Amplitude	72.44 (8.59) -590.60 (315.60)	70.88 (8.78) -434.20 (231.73)	1.56 (-6.00, 9.12) -156.40 (-292.82, -19.98)	0.573(4) -3.18(4)	0.597 0.033

This study found that there were no significant mean differences of both the amplitude and implicit time between pre-exposure data without correction and the pre-exposure data with correction for N1, P1 and N2 among two different refractive groups. Both parameters of different waveforms were not affected by the refractive status of the subject. It has been noted that the electrophysiology activities on the retinal layers were not affected by the presence of optical correction. In the optical aspect, the correction with spectacle did little to none to the changes of the mfERG findings. A few studies have discussed about this factor. Gupta *et al.* [25] stated that the reduction of mfERG responses is correlated with reduced retinal image size and the retinal illumination for people with longer axial length such as myopic eyes. Past study also suggested that the reason why ERG amplitude decreased in myopic eyes might have been contributed by the elongated axial length which caused smaller image size and reduced retinal illumination [26]. Furthermore, the reduced retinal illumination could not account for the diminished ERG response, as highly myopic eyes exhibited significantly lower saturated amplitudes compared to emmetropic eyes.However, these studies did not specify whether optical correction causes the electrophysiological changes or not.

This finding of this study agreed with Amorim-de-Sousa *et al.* [14] that conducted a study to compare the mfERG response in keratoconus eyes using scleral lens and spectacle correction, to which they found that the scleral lens did not show any significant difference of implicit time changes on the mfERG response despite improving the visual performance. However, they observed only a slight reduction in P1 amplitude, which remained comparable to that of non-keratoconus patients. Even though these authors were comparing between scleral lens and spectacle correction, but their main concern was whether optical correction affect mfERG findings or not. The aim was almost the same as this current study where the mfERG was performed to a subject with two different conditions (with optical correction and without optical correction).

Furthermore, a study about myopia progression control using dual-focus lens found that this optical intervention causes changes in the central retinal activities with the boundary approximately 10 degrees of retinal eccentricity [27]. This author managed to observe the possible increment of global-flash mfERG when the participants wore correction in the form of dual-focus lens [28]. Both findings differ from this current finding where no significant difference was observed in the mfERG response when the subjects were using their

spectacle correction and without the spectacle. This conclude that using correction during the mfERG does not provide any remarkable difference in the electrophysiological pattern.

Two of the subjects were spectacle wearer with the refractive error. The effect of the electronic task was observed based on whether there were changes in the electrical activities of the retina or none when the subjects experienced visual stress from the electronic near task. From this study, it was observed that there were no significant mean differences between pre-exposure data and post-exposure data in both implicit time and amplitude of all waveforms. These were the case for both subjects, Eye 3 and Eye 4. Both subjects were low myopes with best corrected VA 6/6. As discussed earlier, optical factors do not affect the mfERG findings even though it improves the visual performance significantly [14]. For both subjects, the effect of electronic task was not apparent, thus agreed with findings by Amorim-de-Sousa *et al.* [14] and Turnbull *et al.* [28].

Except for N1 amplitude of Eye 2 and N2 amplitude for Eye 4, the other findings showed no significant mean difference between pre-exposure amplitude and post-exposure amplitude. N1 response was common in electrophysiological study that concerns with refractive error however the N2 was only mentioned for electrophysiological study among subjects with ocular abnormalities such as glaucoma. A study by Gölemez *et al.* [29] found that N2 response especially for central ring showed altered amplitude and implicit time, which may be able to help detect early glaucoma. If optical correction was excluded, the findings can be explained more by looking into the anatomical aspect of the eye.

The refractive status included were emmetropia, simple hyperopia, simple myopia, and compound myopic astigmatism. All of which was within the low to moderate refractive error. Park *et al.* [30] identified two broad categories proposed to explain the mechanism underlying reduced mfERG responses in high myopia: electrical factors and retinal factors. Regarding electrical factors, they suggested that increased axial length in high refractive error could elongate the distance between the retinal electrical source and the electrode, thereby attenuating the signal.

For this study, even though the axial length was not assessed, however it can be assumed the range of refractive error for the subjects imply normal axial length. Although the subjects were exposed to electronic near task, there were no remarkable observation obtained from the mfERG response. In an article by Chen *et al.* [16], the authors mentioned about the delayed implicit time in P1 for myopes compared to emmetropes when axial length is accounted for, the finding became statistically significant. However, for this study, two myope subjects (Eye 3 and Eye 4) showed no significant mean difference between pre-exposure and post-exposure implicit time of P1. For this study, the axial length was not accounted for, therefore the findings agreed with Chen *et al.* [16] where the mfERG responses between different refractive error groups were not significantly different.

Therefore, hypothetically, if future study was conducted with higher refractive error, the changes in mfERG responses would be significant to give the information of whether post-exposure to near task has effect on the electrical activity of the retina. This can be explained anatomically. For higher degree of myopia, the increment of axial length by 1-millimetre affects the foveal response where there was "a reduction of 2.4nV/deg^2 and 7.4nV/deg^2" specifically for the N1 amplitude and P1 amplitude [19, 25].

V. CONCLUSION

In conclusion, there was no significant changes of the mfERG pre-exposure measurements of subjects with different refractive errors with and without refractive corrections. Secondly, it was observed that the mfERG measurements of full corrected subjects with different refractive errors showed no significant mean difference. Lastly, there was no significant changes of the electrophysiological pattern after near work among subjects with different refractive error without refractive correction.

Present study was conducted to participants with low refractive error and the sampling focused more on the total accumulated results. From the results analysis, the results were not significant since low refractive error has minimal effect on the electrophysiology of the retina even after near tasks. Lastly, the small sample size made it impossible to generalise the electrophysiological changes on different refractive status. Future study can focus more on the high refractive error group to observe more significant changes on electrophysiological pattern. Furthermore, future study should also increase the number of participants in the research to be able to see the pattern distribution of electrophysiological patterns among different degrees of high refractive error.

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AUTHOR CONTRIBUTIONS

Saiful Azlan Rosli: Project Administration, Conceptualization, Supervision, Data Analysis, Validation.

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CONFLICT OF INTERESTS

No conflict of interests was disclosed.

ETHICS STATEMENTS

Our publication ethics follow The Committee of Publication Ethics (COPE) guideline. https://publicationethics.org/

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