

## Electrophysiology Activity of the Photoreceptors Using Photopic Adapted Full-Field Electroretinogram in Young Malay Adults

*Ai-Hong Chen, Saiful Azlan Rosli, and Muhamad-Syukri Mohamad Rafiuddin*

Optometry, Faculty of Health Sciences, Universiti Teknologi MARA (UiTM),  
Selangor, Malaysia

Copyright © 2013 ISSR Journals. This is an open access article distributed under the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**ABSTRACT:** The full-field electroretinogram (ffERG) was used as an electrophysiological test of retinal function. The electrophysiology activity of the photoreceptors in the retina was investigated using photopic adapted full-field electroretinogram (ffERG) in a sample of Malay ethnic (Melayu), (mean  $21.72 \pm 0.88$  years old). About 10 minutes room illumination of photopic adaptation was used, single flashes of  $3 \text{ cd.s.m}^{-2}$  presented until 4 similar artifact free ERG waveforms, and 30 Hz flickers ERG was averaged based on 15 sweeps of 250 milliseconds (ms) duration, which based on the International Society of Clinical Electrophysiology of Vision (ISCEV) 2008 ERG Standard. The mean, standard deviation and median of amplitude ( $\mu\text{V}$ ) of cone a-wave ( $-30.73 \pm 12.49$ ,  $-29.22$ ) and cone b-wave ( $119.26 \pm 37.76$ ,  $119.45$ ), and the latency time (ms) of cone a-wave ( $14.30 \pm 1.15$ ,  $14.50$ ) and cone b-wave ( $30.02 \pm 0.98$ ,  $30.00$ ), 30 Hz peak amplitude ( $97.12 \pm 28.63$ ,  $86.51$ ), and latency time for peak ( $26.27 \pm 1.77$ ,  $26.00$ ) and trough ( $13.13 \pm 2.10$ ,  $13.00$ ) respectively were shown in descriptive data. The normal value of young Malay adults as the baseline data for Malay population and comparable to other population around the world is important for ffERG practical.

**KEYWORDS:** Full-field Electroretinogram, Electrophysiology, retinal function, room illumination, cone adapted.

### 1 INTRODUCTION

Electrophysiology function of the retina was widely tested using the full-field electroretinography (ffERG), which should be standardized and comparable throughout the world [1]. The ffERG was used in detecting various retinal problems affecting the photoreceptors such as Rod-Cone Dystrophies, the Retinal Pigment Epithelium (RPE) disease likes Retinitis Pigmentosa and other retinal layers.

Base on the standard protocol from International Society of Clinical Electrophysiology of Vision (ISCEV) 2008, the two most common investigations used to find out the functional values of the photoreceptors; scotopic ffERG (dark-adapted ffERG) and photopic ffERG (light-adapted ffERG). This investigation was performed by having the subject on light adapted in room illumination for at least 10 minutes. Meanwhile, the dark-adapted ffERG was used to investigate the rod photoreceptors as they were activated during scotopic condition [2].

Even though these factors had been investigated extensively, the majority of the tests were performed on either Caucasian population in Americas or Europe while the Asian populations mainly from the ethnic group of Japanese, Chinese or Persian. Currently, there are limited studies using ERG whether ffERG or mfERG on the Austronesian people in particular young Malay (*Melayu*) population.

Malay or *Melayu*, which primarily inhabits the Malay Peninsula including Malaysia, was originating from an ethnic group of Austronesian peoples (as its main ethnic group comprising of 50.4% of the population). The current Malays were the descendants of Iron Age people from the Chams of Mainland Southeast Asia, who migrated to the peninsular and islands of Southeast Asia around 300 BC, called Deutero Malays [3]. Deutero Malays were the relatives of Proto Malays that are now known as Aboriginal People (*Orang Asli*) in Malaysia. The Proto Malays were also of Austronesian origin that was thought to

have migrated to the Malay Archipelago between 2500 and 1500 BC, earlier than Deutero Malays. However, Proto Malays were forced to migrate deeper into the hill and further upriver due to the Deutero Malays influences, which settled on coastal and downstream areas [4]. In corresponded to the East Asian such as Chinese, Japanese and Korean, the Human Genome Organization (HUGO), who investigated the human genome and do the genome mapping across the world, had postulated that the South East Asian civilizations including Malays are possibly much older than the East Asian civilizations. This finding suggested that East Asian population originated from the South East Asian population [5][6].

The function of the photoreceptors cells in a sample of Malay population using ffERG was reported in this study. The functions were represented by the values produced by the ffERG and this had direct connection to retinal cells activities in this sample population. Population variation on electrophysiology respond also suggested in the study done by Al Abdlseaed et al. and Fulton et al. [7] [8].

## **2 RESEARCH METHOD**

All data collection was carried out at the Advanced Electrophysiology for Vision Laboratory (AEVo Lab), Optometry Clinic, Universiti Teknologi MARA (UiTM), Malaysia. Thirty-two subjects with the age range of 18 – 24 years old were recruited. The ethnicity of the subjects was confirmed by checking their national identity card under the race and ethnic section. The ethical consideration of this research had been approved by the institution of the researcher, and followed the tenet of the Helsinki Declaration.

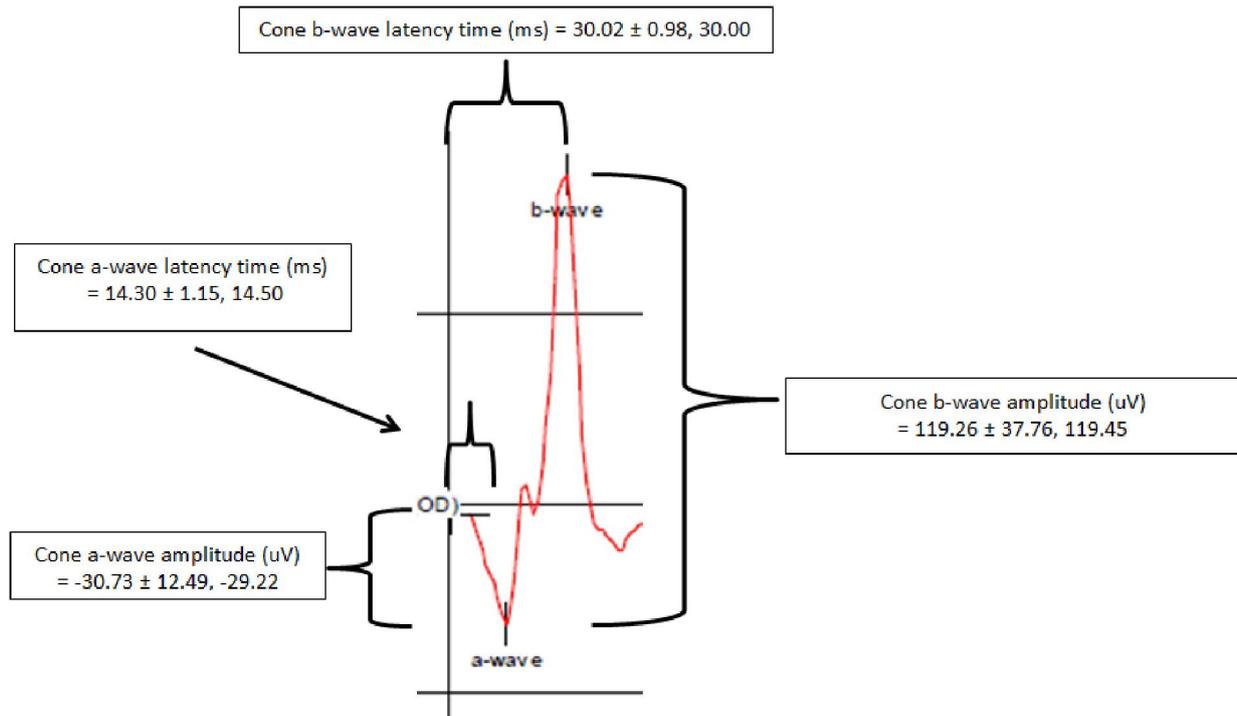
Prior to the investigation using the ffERG, subjective refraction, funduscopy, slit lamp examination, color vision testing, binocular vision testing and intra-ocular pressure measurement were measured. Subjects with color vision defects, binocular vision problems like strabismus, ocular diseases including history of retinal and corneal disorders were excluded, to avoid complication during dilation due to high intra-ocular pressure. Subjects were included with the refractive error less than  $\pm 6.00$  D, who represented low to moderate degree of ametropia, had Best Corrected Visual Acuity (BCVA) of 6/6, normal color vision and normal binocular vision.

After full dilation, the subject was light adapted in room illumination for 10 minutes. After light adaptation, the pupil size of the subjects was measured with conventional pupillary size ruler, before performing photopic ffERG. Photopic ffERG protocols included single flashes of  $3 \text{ cd.s.m}^{-2}$  that were presented until 4 similar artifact-free ERG waveforms were obtained and averaged (the Cone ERG). And later on, 30 Hz flickers ERG was averaged based on 15 sweeps of 250 milliseconds (ms) duration (the 30 Hz Flicker ERG).

The ffERG subject preparation and protocols for photopic stimulation followed the ISCEV Standard 2008 set by the International Society for Clinical Electrophysiology of Vision (ISCEV) [2].

## **3 RESULTS**

The mean, standard deviation and median for cone a-wave amplitude, cone a-wave latency time, cone b-wave amplitude and cone b-wave latency time for photopic ffERG were presented in Figure 1. For the light adapted 30 Hz flicker, the amplitude of peak ( $\mu\text{V}$ ) in mean, standard deviation and median were  $97.12 \pm 28.63$  and  $86.51$  respectively, while the latency time (ms) for peak and trough in mean, standard deviation and median were  $26.27 \pm 1.77$  and  $26.00$ ,  $13.13 \pm 2.10$  and  $13.00$  respectively.



**Fig. 1. Summary of mean, standard deviation (SD) and median for photopic adapted cone responses (indication: mean ± SD, median)**

The comparison of a-wave amplitude and implicit time, b-wave amplitude and implicit time for photopic condition between our study and other population was summarized in Table 1. Comparing the findings from UK, Canada and USA, there was a large difference on the a-wave amplitude, where negative value rather than positive value was recorded in our population. The minimum value also recorded for amplitude of b-wave in our population. The different locations revealed different value especially on median amplitude of a-wave and b-wave in comparison to our study. The lowest value on median amplitude and almost the same pattern on median latency time of a-wave and b-wave were recorded in our study.

**Table 1. Comparison the photopic adapted on different population [7] [8]**

Study	(Al Abdlseaed, McTaggart, Ramage, Hamilton, & McCulloch, 2010)		(Fulton, Hansen, & Westall, 2003)		Saiful A.R, Muhamad-Syukri MR, & Chen A.H., 2013
Population	Blue-eyed Caucasians	Brown-eyed Asians	Boston adults	Toronto adults	Young Malays Adult
Location	Glasgow Caledonian University, UK		Boston, USA	Toronto, Canada	Klang Valley, Malaysia
<b>ffERG Parameter Mean (95 CI)</b>					
a-wave amp (IV)	39 (34 to 46)	52 (47 to 58)	N/A	N/A	-30.73 (-35.1 to -26.4)
a-wave lat (ms)	14.6 (14.2 to 15)	14 (14 to 14)			14.30 (13.9 to 14.7)
b-wave amp (IV)	133 (115 to 153)	209 (179 to 245)			119.26 (106.2 to 132.3)
b-wave lat (ms)	29.7 (29.4 to 30.1)	29.1 (28.6 to 29.7)			30.02 (29.7 to 30.4)
<b>ffERG Parameter Median</b>					
a-wave amp (IV)	N/A	N/A	92	42	29.22
a-wave lat (ms)			15	14	14.5
b-wave amp (IV)			137	164	119.45
b-wave lat (ms)			28	29	30

N/A = not available

#### **4 DISCUSSION**

Our finding on ffERG will serve as a preliminary guide for ERG measurement in clinical setting for young Malay adults as well as a guide for main comprehensive normative data collection in future. The values were considered important, as this is the first study that produced such values for this population. Comparing the five different populations, the lowest values were recorded in our population. Most probably due to 'internal factor' rather than the technical factor such as age, race, pupil size, axial length, diurnal variation, geographical environment, the genetic contribution, the physical of the retina in different population and the quality of electrical potential produced by the retinal cells [9]. In addition to that, the ffERG values also reflected the conditions and wellbeing of the retinal cells. Values of the electrical potential from the retina produced by the retinal cells had direct relationship to the functions of the cells as specific as the biochemical reaction involved in creating the signals.

#### **5 CONCLUSION & RECOMMENDATION**

A normative data is recommended for Malay population. The ffERG values for Malay Malaysian can be used as additional information to detect abnormalities in the electrophysiology practice besides using data from other population.

#### **ACKNOWLEDGEMENTS**

This study supported by Fundamental Research Grant Scheme (FRGS) (600-RMI/ST/FRGS 5/3/Fst 45/2011) and Exploratory Research Grant Scheme (ERGS) (600-RMI/ERGS 5/3 59/2011) from Minister of Higher Education Malaysia, and UiTM for the facilities. This work is in collaboration with Associate Professor Dr. Stuart Coupland, from University of Ottawa, Canada.

#### **REFERENCES**

- [1] M. Marmor, G. Arden, S. Nilsson, and E. Zrenner, "Standard for clinical electroretinography: International standardization committee," *Archives of Ophthalmology*, vol. 107, no. 6, 1989.
- [2] M. Marmor, A. Fulton, G. Holder, Y. Miyaki, M. Brigell, and M. Bach, "ISCEV Standard for full-field clinical electroretinography (2008 update)," *Doc Ophthalmol.*, vol. 118, no. 1, pp. 69-77, 2009.
- [3] A. Collins, *Security and Southeast Asia: domestic, regional, and global issues*. Institute of Southeast Asian Studies, 2003.
- [4] N. J. Ryan, *A history of Malaysia and Singapore*. Oxford University Press, 1976, p. 322.
- [5] HUGO, "Mapping Human Genetic Diversity in Asia," vol. 326, no. 5959, pp. 1541-5, 2009. doi: 10.1126/science.1177074
- [6] BBC News, "Genetic 'map' of Asia's diversity," no. November, 2009.
- [7] A. Al Abdiseaed, Y. McTaggart, T. Ramage, R. Hamilton, and D. L. McCulloch, "Light- and dark-adapted electroretinograms (ERGs) and ocular pigmentation: comparison of brown- and blue-eyed cohorts.," *Documenta ophthalmologica. Advances in ophthalmology*, vol. 121, no. 2, pp. 135-46, Oct. 2010.
- [8] A. B. Fulton, R. M. Hansen, and C. a Westall, "Development of ERG responses: the ISCEV rod, maximal and cone responses in normal subjects.," *Documenta ophthalmologica. Advances in ophthalmology*, vol. 107, no. 3, pp. 235-41, Nov. 2003.
- [9] R. Karanjia, M. W. Hove, and S. G. Coupland, *Electroretinograms and Normative Data*. In: Gregor Belusic, *Electroretinograms*, InTech, 2007. DOI: 10.5772/23387