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Research Article

Visual Evoked Potential in Myopia

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Abstract

Purpose: To determine how the magnitude of myopia influences the parameters of pattern visual evoked potential (VEP) and multifocal visual evoked potential (MVEP).

Subjects and Methods: One hundred and eighty eyes of 180 normal volunteers with good visual acuity and without glaucoma were included in the study. The subjects were divided into four groups.

The groups were emmetropia with refractive error (±0.25D), low myopia (-0.25D to -4.00D), Moderate myopia (-4.2SD to -8.00D) and high myopia (>-8.00D). All subjects were tested on flash VEP, pattern VEP, multifocal visual evoked potential (M-VEP) and static automated perimetry (SAP).

M-VEP positive peak wave (p) amplitude and latency were measured for all groups. Also,P100 amplitude and latency of PVEP were detected. Mean deviations (MD) and Corrected pattern standard deviation (CPSD) of SAP were determined. The relationship between refractive error, PVEP, M-VEP parameters and SAP values were assessed.

Results: For low myopia, there were no significant correlation between SAP values and spherical equivalent. For moderate and high myopia, there were decrease in mean sensitivity and mean deviation as degree of myopia increase. While both PVEP and M-VEP amplitudes and latencies in mild and moderate myopia were similar to emmetropia, in high myopia, P wave amplitude decreased and P wave latency increased slightly.

Conclusion: Low and moderate myopia does not alter the visual field obtained by M-VEP or parameters of PVEP with slight affection of VEP parameters in high myopia**.**

Keyword: Myopia; Multifocal Visual Evoked Potential; PVEP; SAP

Introduction

The multifocal visual evoked potential (M-VEP) is a useful tool for objective evaluation of optic nerve disease and visual defects secondary to optic nerve or retinal ganglion cell damage [1,2].

Most of the visual evoked potential (VEP) responses are from the central retina within 5° to 8° of the visual field and the responses from the peripheral areas are difficult to measure. Detection of visual field defects in using multifocal VEP is performed. The technique enables measurement of VEP from the more peripheral retina with high signal to noise ratio. Intraocular comparison of M-VEP enables detection of localized field defect [3,4].

There is evidence that different retinal functions can be selectively altered by myopia [5,6].

There is a loss of sensitivity of the short-wave length-sensitive cones in myopic eyes by static automated perimetry and by VEP. It was found a reduction of the amplitude and a delay of the implicit

times of each wave of the multifocal electroretinogram in myopic eyes [7,8].

Ocular hypertension, primary open angle glaucoma and low tension glaucoma were found to occur more frequent in myopic patients than in normal population of similar age group [9].

Also, visual field defects increases as the magnitude of myopia increase so, it is important to distinguish the changes in visual field introduced by glaucoma from those caused by myopia. However, It has not been determined whether the visual fields assessed by M-VEP are altered by myopia or not.

This study was conducted to determine how the degree of myopia influences the visual field as measured by M-VEP.

Patients and Methods

This study was conducted on patients attending the Outpatients Clinic of Mansoura Ophthalmic (enter from March 2020 to March 2022. the study included 180 eyes of one hundred and eighty emmetropic or myopic volunteers with best corrected visual acuity 6/6 or better.

The subjects were divided into four groups: according to refractive error measured by an Auto refractometer and full trial of refraction.

First group (45 eyes) was emmetropia with refractive error ± 0.25D, second group (44 eyes) had mild myopia with refractive error ranged from (-0.25D to-4.00D), third group (48 eyes) had moderate myopia with refractive error ranged from (-4.25D to -8.00D) and fourth group (43 eyes) had high myopia (more than - 8.00D).

All subjects underwent full ophthalmic examination included: best corrected visual acuity, full cycloplegic refraction using (canon Auto refractometer), fundus examination Using (direct ophthalmoscopy, indirect ophthalmoscopy and Goldmann 3-mirror), ocular tension measurement using Goldmann applanation tonometry, multifocal visual evoked potential (M-VEP) and achromatic static automated perimetry (SAP).

The procedures were fully explained to all subjects and informed consents were obtained before the tests.

Exclusion criteria were visual acuity worse than 6/9, Previous intra-ocular surgery, IOP21. Gonioscopic findings of angle closure glaucoma, evidence of uveities, pseudo- exfoliation or pigment dispersion syndrome on slit lamp examination, opacities in the media, retinal pathology or neurological abnormalities that would affect the visual field or prevent accurate visual field testing. Also, history of glaucoma or other optic neuropathies, a family history of glaucoma in a first degree relative were considered reasons for exclusion.

Static automated perimetry

Subjects underwent static automated white on white full threshold perimetry (program 24-2, Humphrey Field Analysis 640 Carl Zeiss Co). All subjects wore trial lenses in the perimeter frame.

The following criteria were used for reliability: fixation loss less than 20%, false positive less than 33% and false negative less 33%.

An abnormal visual field was defined according to Andersen criteria as abnormal glaucoma hemi field test with three or more contiguous points on the pattern deviation plot depressed at the P less than 5% level, at least one of which must be depressed at the P less than 1% level and an abnormal corrected pattern standard deviation with P less than 5% occurring in the normal population.

For subjects with abnormal visual field, the visual field test was repeated twice (one week apart) to check reproducibility of the defect. Subjects with unreliable visual field also underwent a repeated test and if they failed to meet the reliability criteria again, the visual field was not used in the analysis. The mean deviation (MD) and corrected pattern standard deviation (CPSD) are recorded.

Visual evoked potential

Visual evoked potential were recorded using (Roland Consult, Brandenburg, Germany). The pupils of patients were approximately 5 mm; Mydriatics or miotics drugs were never used. Patient eyes were properly patched to ensure good dark adaptation for 10 minutes. VEP Was done follow ISCEV parameters [10].

Multifocal visual evoked potential(M-VEP) was recorded using a multifocal objective perimeter which Simultaneously stimulates multiple sites within the visual field and extract, corresponding VEP Signals from these sites. The visual stimulus was generated

on a computer screen with a stimulation rate of 75 HZ. 56 closely packed segments in a dart-board configuration were used with two additional segments located in the nasal step region.

The segments were cortically scaled with eccentricity to stimulate approximately equal areas of cortical surface (Figure 1).

Figure 1A: Cortically scaled stimulus consists of 56 close packed segments with two additional segments located in the nasal step region.

Figure 1B: Patient sitting in front of MFERG monitor.

The cortical scaling produced a signal of similar amplitude from each stimulated segment. Each segment contained a checkerboard pattern (16) checks with the size of individual checks being proportional to the size of the segments, and therefore also dependent on eccentricity.

The central area of 1" was not stimulated, but used as a fixation monitor.

The distance to the screen was 30 cm. All subjects had optimal refraction for near and pupils were not dilated. All recordings were collected using monocular stimulation.

Data were recorded using a four- channel amplifier. Silver-silver chloride electrodes were used. A custom-designed occipital electrode holder predetermined the four electrode position!' It was light weight and comfortable for the patient and neck muscles remained relaxed.

The scalp was cleaned at each site before finalizing the electrode position. All recordings performed with the level of resistance between electrodes lower than 10K. Four channels were used to cover different underlying dipole orientations. The vertical channel comprised electrode 3 cm below inions and 3.5cm above inions. The horizontal channel linked the two electrodes 4cm either side of the inions. The ground electrode is connecting to middle of forehead. Conductive gel or land sodium chloride solution is used to ensure good connection of the electrode.

VEP traces were analyzed using custom- designed software. Largest peak-to-trough amplitudes for each wave within the interval of 60-180 milliseconds were determined and compared among channels for every stimulated segment of the visual field.

The wave of maximal amplitude from each point in the field was automatically selected and a combined topographic map was created by software.

A combined trace array was then used for further analysis. The VEP amplitude was averaged over the whole visual field (all 58 segments) for each subject.

Pattern VEP

3 types of electrodes were applied to the patient. The forehead was thoroughly cleaned by piece of cotton soaked in alcohol to remove any dirt then negative electrode was applied to forehead. Cup shaped, positive electrode and ground are fixed with gel to back of head (one finger from inion; inions: projection at the middle the back of the head) and at line of ear lobule respectively After cleaning the back of the head by alcohol and separation of hair.

Subjects were seated comfortably in a chair and asked to fixate at the center of the stimulus pattern The luminance of the white check was 200 candles/meter' (200 cd/m^2) and the luminance of the black was 1 (1 cd/m^2) producing a Michelson contrast of 99%.

Luminance of the screen was maintained at a mean level of 75 cd/m^2. A dim room light was always on.

The signal was amplified 100.000 times and band pass filtered between 3 and 30Hz. usually eight runs were recorded to provide a good signal to noise ratio. Runs contaminated by high level of noise were rejected.

Statistical analysis

Data were analyzed using Statistically Package for Social Science (SPSS). Chi square test and test of significance were used for analysis of the relationship between global indices of SAP, spherical equivalent and M-VEP parameters between groups. Spearman 'correlation coefficient was used to calculate correlation between variables. P < 0.05 is considered statistically significant, R > 0.5 is considered good correlation.

Results

The study included: 180 subjects (180 eyes). The study included 90 females and 90 males, aged from 17 to 35 years. There were no difference among groups with regard to age and sex, (P = 0.00).

All subjects had normal intra-ocular pressure {less than 21 mmHg), normal fundus apart of tigroid appearance in high myopia.

There were two subjects (1.1%) who had significant reproducible visual field defect (P = 0.005). In one subject the defect was of a nasal step pattern, the refractive error of this subject was -5,00D. The retina and optic disc were otherwise normal. The VEP parameters were normal. In other subject, the defect was superior arcuate scotoma with refractive error - 8.50, the optic disc and VEP parameter were normal with absence of tilted disc (Figure 2). In another two subjects (1.1%), there were generalized reductions of sensitivity on glaucoma hem; field test. Their refractive errors were -12.0D/-0.5 axis 90 and -11.0/-0.25 axis 180.

In the remaining 176 subjects (97.8%) had no significant visual field defect on SAP. In group 1 and group 2 (myopia 4.00D), there were no significant correlation between MD and spherical equivalent.

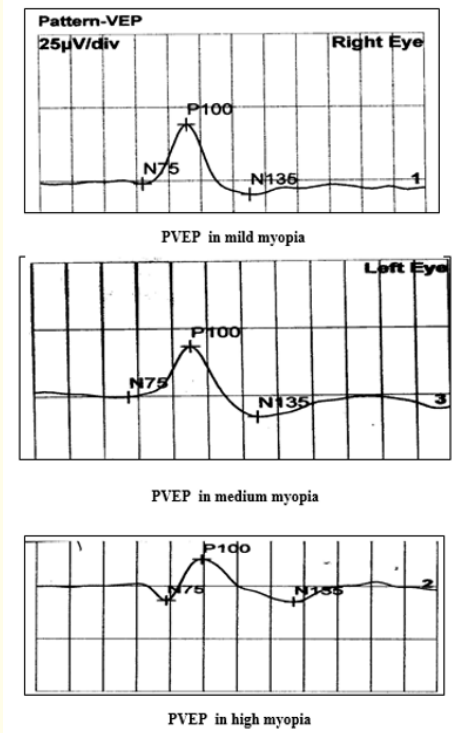

Figure 2: PVEP among myopic groups.

In group 3 and group 4 (myopia more than -4.00D), MD decreased significantly as degree of myopia increases. CPSD did not exhibit any significant linear correlation with spherical equivalent (Table 1).

	MD	CPSD
Group (1)	0.11	0.100.4
Group (2)	0.230.11	0.130.3
Group (3)	0.500.2	0.140.29
Group (4)	0.550.4	0.330.9

Table 1: Correlation between myopia and visual field parameters at P > 0.001.

Regarding MFERG, no reduction of amplitude of M-VEP towards periphery was noticed in emmetropia and in other groups. The values of M-VEP over rings and quadrants among groups were included in figures 3-5 (Table 2-3), There were good correlation

between mean M-VEP amplitude and mean deviation of SAP in only group 4 (R = 0.5, P = 0.00) While no correlation between M-VEP amplitude and mean deviation in other groups (R = 0.1, 0.11, 0.12, P = 0.00).

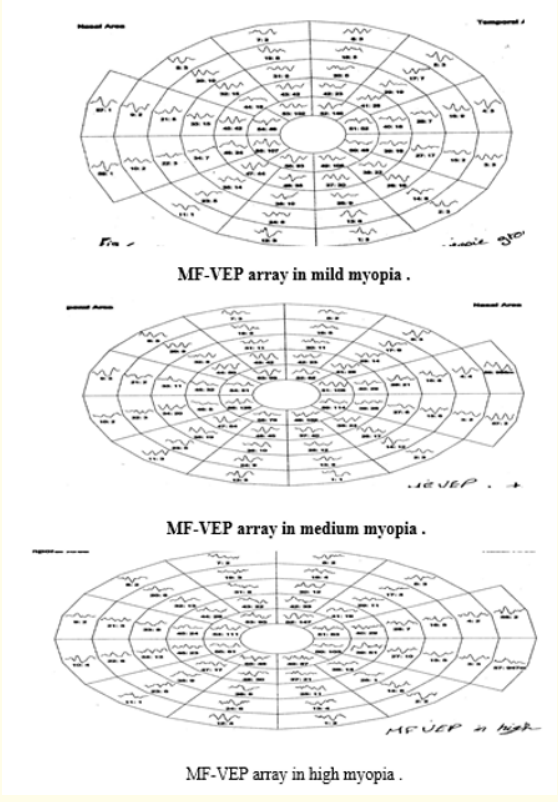

Figure 3: MF-VEP trace array among myopic groups.

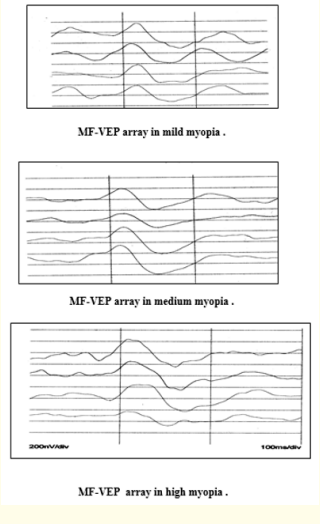

Figure 4: MF-VEP over quadrants among myopic.

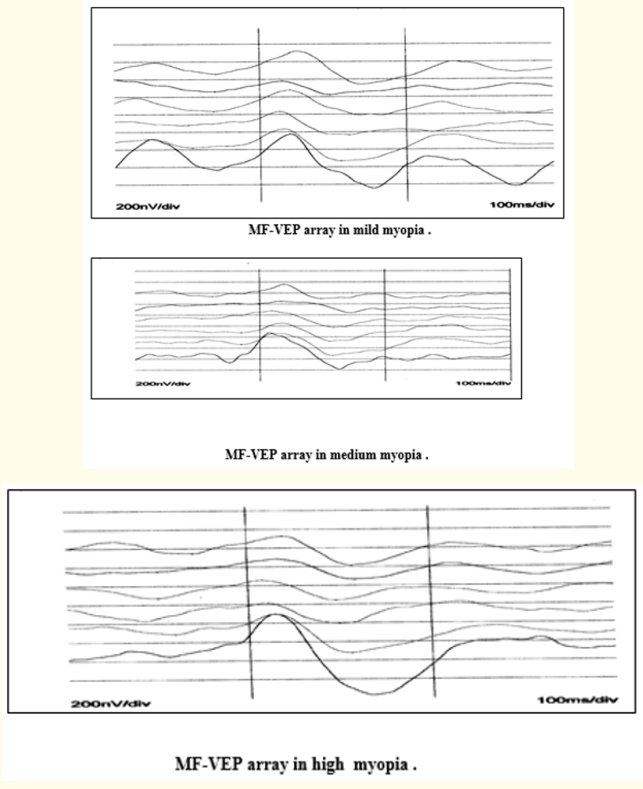

Figure 5: MF-VEP over rings among myopic groups.

Also, there were no correlation between M-VEP amplitude and degree of myopia (myopia less than -8.000, (R = 0.13, P = 0.002). There were good correlation between M-VEP amplitude and spherical equivalent for myopia more than 8.000 (R = 0.52, P = 0.001).

As regard, M-VEP latencies, there were prolongations of M-VEP latencies in group 4 only while no difference in M-VEP latencies in other groups.

Regarding PVEP, there was statistically insignificant change in p100 amplitude and latency in group 1,2,3 while in group 4, there was slight reduction of amplitude and prolongation of p100 (Table 4, figure 2).

Discussion

Changes in the visual field of myopic individuals are possible confounding factors in the diagnosis of glaucoma. Humphrey field analysis full threshold program white on white perimetry has been shown to be affected by myopia [11].

	GROUPS	R1	R2	R3	R4	R5	R6
Amplitudes	Group (1)	230	240	235	220	200	400
	Group (2)	233	23022	23423	22525	21010	40510
	Group (3)	235	23524	23133	22817	22020	40220
	Group (4)	21012	21512	22925	22925	11510	38015
Latencies	Group (1)	1003.0	1025.0	1042.0	1054.0	1063.0	1074.0
	Group (2)	1013.0	1044.0	1062.0	1063.5	1082.0	1083.0
	Group (3)	1033.0	1053.0	1063.0	1064.1	1072.0	1084.0
	Group (4)	1105.0	1145.0	1154.0	1136.0	1166.0	116

Table 2: M-VEP Amplitudes in Nano-volt and latencies in over rings (R).

	Groups	SN	IN	IT	ST
Amplitudes	Group (1)	290	270	250	260
	Group (2)	280	17514	26020	24010
	Group (3)	285	27717	25513	24415
	Group (4)	25040	23515	22818	23010
Latencies	Group (1)	1005.0	1013.0	1033.5	1013.0
	Group (2)	1052.0	1034.0	1065.0	1043.5
	Group (3)	1065.0	1075.0	1076.0	1055.1
	Group (4)	1138.0	1164.0	1142.0	1112.0

Table 3: M-VEP Amplitudes and latencies over quadrants.

	P100	P100 latency
Group (1)	10.33.9 $p > 0.1$	101.51.1 $P = 0.10$
Group (2)	10.13.2 $p > 0.2$	102.2 1.5 $P = 0.13$
Group (3)	10.0 $p > 0.4$	101.91.8 $p = 0.14$
Group (4)	10.9 $p < 0.01$	104.4 3.5 $p = 0.03$

Table 4: PVEP parameters among groups.

Glaucoma in myopic subjects results in dense localized defect that threaten fixation, upper- temporal defects, enlarged blind spot, typical and atypical nerve fiber bundle defects It is not known if these defects were the result of glaucoma or related to myopia. Also, short wave length perimetry results are affected by myopia. Perdicchi., *et al*. [12,13] found that visual field was altered in most of the eyes. With high myopia and worsened with the increase of myopia. Thus the effect of myopia must be taken into account when interpreting visual field. Objective detection of MF-VEP recording provides a unique opportunity for studying visual field defects. Multiple domains/loci of the visual field are simultaneously stimulated using a cortically scaled pseudo randomly reversing pattern stimulus. Visual evoked potentials corresponding to each of the loci of the visual field tested can be recorded within a short period of time to generate a perimetry of VEP. Its objective nature; need for minimum cooperation from the subject and short recording time make it an ideal technique for investigating visual field. However, there were no studies have been reported the effect of myopia on M-VEP.

In this study, the latencies and amplitudes of positive peak of the waves of MF-VEP were analyzed and were not differ significantly for mild and moderate myopia but, in high myopia, there were slight prolongation of latencies and reduction of amplitude.

In this study, there were alterations of SAP parameters in moderate and high myopia. There were reductions of MD with generalized loss of sensitivity that proportional to degree of Myopia.

Also, Aung., *et al.* [14] found reduction of threshold sensitivity in moderate and high myopia. The same as Czepita and Chmielewska [15] who reported that, high myopia leads to reduction of mean sensitivity and MD.

However, Perdicchi., *et al.* [13] confirmed that optimal corrected and uncorrected myopia up to 3.25D does not produce quantitative visual field defects, when tested by static automated perimetry, also, in optimally corrected myopia up to 5.50 D, quantitative visual field defects did not found.

There are several reasons for this generalized loss of sensitivity in myopic subjects, these include ectasia of the fundus structural changes in the retina and choroid which may not be ophthalmologic ally visible, axial elongation of the eye with increased spacing or distortion of retinal photoreceptor matrix and minification with distortion of the stimulus [16,17]. Thus generalized reduction of sensitivity in moderate and high degrees of myopia should be taken into consideration in the interpretation of SAP, There was one case with nasal step and other with arcuate scotoma on SAP but not present in M-VEP, the explanation for this: First, M-VEP is objective not subjective test, second, stimulus size for SAP is a point of less than 10 of visual field, third, a fatigue effect in myopic eyes may be a responsible for poor results of SAP [18,19].

Regarding PVEP, there was only reduction in amplitude and delay in latency only in high myopia in this study.

Similarly, Dani., *et al.* [20] observed prolongation in p100 in high myopia.

While, Masaya., *et al.* [21], Ruchi., *et al.* [22] found no significant difference between emetropia and myopic eyes.

In summary, there were good correlation between MD of SAP and M-VEP (amplitude and latency) in high myopia. While, there were no significant changes in M-VEP parameters in mild and moderate myopia, thus, the effects of myopia up to 8.00D can be ignored “hen testing the visual field using M-VEP.

Conclusion

In summary, there were good correlation between MD of SAP and M-VEP (amplitude and latency) in high myopia, While, there were no significant changes in M-VEP parameters in mild and moderate myopia. Thus, the effects of myopia up to 8,00D can be ignored when testing the visual field using M-VEP.

Bibliography

1. Mustafa Y., *et al*. “Visual Evoked Potential in Idiopathic Intracranial Hypertension”. *Journal of Clinical and Experimental Ophthalmology* 10.782 (2019): 2.

2. Minami T., *et al*. “Steady-state visually evoked potential is modulated by the difference of recognition condition”. *PLoS One* 15.7 (2020): e0235309.

3. Zheng X., *et al*. “Objective and quantitative assessment of interocular suppression in strabismic amblyopia based on steady-state motion visual evoked potentials”. *Vision Research* 164 (2019): 44-52.

4. Pihl-Jensen G., *et al*. “Predictive value of optical coherence tomography, multifocal visual evoked potentials, and full-field visual evoked potentials of the fellow, non-symptomatic eye for subsequent multiple sclerosis development in patients with acute optic neuritis”. *Multiple Sclerosis Journal* (2019): 1352458520917924.

5. Ruberto G., *et al*. “Visual Evoked Potentials in Joubert Syndrome: A Suggested Useful Method for Evaluating Future Approaches Targeted to Improve Visual Pathways’ Function”. *Advances in Therapy* (2020): 1-12.

6. Sabeti F., *et al*. “Comparing multifocal pupillographic objective perimetry (mfPOP) and multifocal visual evoked potentials (mfVEP) in retinal diseases”. *Scientific Reports* 7.1 (2017): 1-12.

7. Zheng X., *et al*. “Quantitative and objective diagnosis of color vision deficiencies based on steady-state visual evoked potentials”. *International Ophthalmology* (2020): 1-12.

8. Adachl-Usarni E and Kawabata H. “Short wave length sensitivity measured in myopia by visual evoked cortical potentials”. In: Myopia Updates. Springer-Verlag (2000): 77-79.

9. Parisi V., *et al*. “Neuroenhancement and neuroprotection by oral solution citicoline in non-arteritic ischemic optic neuropathy as a model of neurodegeneration: A randomized pilot study”. *PLoS One* 14.7 (2019): e0220435.

10. Odom J V., *et al*. "ISCEV standard for clinical visual evoked potentials: (2016 update)". *Documenta Ophthalmologica* 133.1 (2016): 1-9.

11. Anju TJ and Parveen QW. "Effect of Myopia on Visual Evoked Potential". *IOSR- JDMS* 14.4 (2015): 49-52.

12. Perdicchi s., *et al*. "Automated static perimetry: the influence of myopic an isometropia on evaluation of visual field". *Coli Anthropology* 1 (2013): 75-81.

13. Perdicchi A., *et al*. "Visual field damage and progression in glaucomatous myopic eyes". *European Journal of Ophthalmology* 17 (2007): 534-537.

14. Aung T., *et al*. "Automated static perimetry: The influence of myopia and its methods of correction". *Ophthalmology* 108 (2001): 290-295.

15. Chmielewska I and Czepita. "Changes in the static visual field of patients with low and medium myopia". *Annales Academiae Medicae Stetinensis* 50 (2004): 21-24.

16. Herba E., *et al*. "Short wavelength perimetry: the significance in diagnosis of glaucoma in myopic patients". *Klin Oczna* 106 (2004): 225-227.

17. 0hno-Matsui K., *et al*. "Long-term development of significant visual field defects in highly myopic eyes". *American Journal of Ophthalmology* 152 (2011): 256-265.

18. Fledelius HC and Goldschmidt E. "Eye shape and peripheral visual field recording in high myopia at approximately 54 years of age, as based on Ultrasonography and Goldman kinetic perimetry". *Acta Ophthalmology* 88 (2010): 521-526.

19. Klistorner A., *et al*. "Multifocal VEP and OCT in optic neuritis: a topographical study of the structure–function relationship". *Documenta Ophthalmologica* 118 (2009): 129–137.

20. Dani J S., *et al*. "Effects on visual evoked potential in myopia". *The International Journal of Basic and Applied Physiology* 9.1 (2020): 41-46.

21. Masaya S., *et al*. "Effects of refractive errors on visual evoked magnetic fields". *BMC Ophthalmology* 15 (2015): 162.

22. Ruchi K and Pradeep B. "Influence of refractive error on Pattern reversal VEPs of Myopes and Hypermetropes". *International Journal of Physiology* 1.1 (2013): 57-61.