Pattern Electroretinographic Recordings in Eyes with Myopia

Miyopisi Olan Olgularda Patten Elektroretinografi

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Abstract
Purpose: Pattern electroretinography (PERG) is a specific test for the analysis of functions of ganglion cells and macula. In this study, the authors investigated the PERG recordings in myopia.
Subjects and Methods: Four groups were formed according to the refraction of 160 eyes of 80 myopic and control subjects as follows: Group 1 (Controls): Between 0.00 and -0.75 D; Group 2: -1.00 and -3.00 D; Group 3: -3.25 and -6.00 D; Group 4: -6.25 and – 10.00 D. Amplitudes and latencies of P50 and N95 waves were recorded in all subjects.
Results: P50 and N95 wave amplitudes were lower in high myopes (Groups 3 and 4) than low myopes (Groups 1 and 2; p<0.05). P50 and N95 wave latencies did not differ between the groups (p>0.05).
Conclusion: Reduction in the amplitudes of P50 may be caused by macular dysfunction and reduction in the amplitudes of N95 may show the functional impairment of ganglion cells in high myopia.

Keywords: **Electroretinography; Myopia; Macula Lutea; Retinal Ganglion Cells.**

Özet
Amaç: Pattern elektroretinografi (PERG), ganglion hücre tabakası ve makula fonksiyonlarını değerlendirmekte kullanılan özgül bir testtir. Bu çalışmada miyopisi olan olgularda PERG sonuçları değerlendirilmiştir.
Hastalar ve Metod: Seksen olgunun 160 gözü refraksiyon düzeylerine göre dört gruba ayrıldı. Grup 1 (kontrol grubu): 0.00 ile -0.75 D arasında, Grup 2: -1.00 ile -3.00 D arasında, Grup 3: -3.25 ile -6.00 D arasında, Grup 4: -6.25 ile -10.00 arasında refraksiyon düzeyine sahip olgulardan oluşmaktaydı. Tüm olgularda P50 ve N95 dalgalarının amplitüd ve latansları kaydedildi.
Bulgular: Yüksek miyopisi olan olgularda (Grup 3 ve 4), düşük miyopisi olan olgulara göre (Grup 1 ve 2) P50 ve N95 dalga amplitüdleri daha düşük bulundu (p<0.05). P50 ve N95 latansları gruplar arasında anlamlı farklılık göstermedi (p>0.05).
Sonuç: Yüksek miyopisi olan olgularda, P50 dalga amplitüdünde azalma makuler fonksiyon bozukluğundan, N95 dalga amplitüdünde azalma ganglion hücre tabakasındaki fonksiyon bozukluğundan kaynaklanabilir.

Anahtar kelimeler: **Elektroretinografi; Miyopi; Makula Lutea; Retinal Ganglion Hücreler.**

Introduction

Pattern electroretinography (PERG) is a useful test for macular ganglion cell and the nevre fiber layer function. In the PERG, the stimulus is a checkerboard or other pattern type stimulus which, as a rule, is viewed with central fixation. Consequently responses relate to macular function (1-3).

In the PERG, macular cones are stimulated with a checker board or pattern type stimuli and consequently, responses related to foveal cones and ganglion cells are obtained. Retinal ganglion cell density is greatest at the macula. Alternating dark and light areas of checker board type stimulates specifically the ganglion cells (3).

The PERG contains two main components. The P50 component is affected by macular dysfunction. In contrast, the ganglion cell origins of the N95 component allow electrophysiological evaluation of ganglion cell function both in primary disease and in dysfunction secondary to optic nevre disease, where selective loss of N95 can be observed (1).

Studies with regard to the evaluation of the function of the ganglion cells and the macula in myopia are very few (4-6). In this study, we aimed to evaluate the function of the central retina in myopia with PERG.

Patients and Methods

This study is performed on 160 eyes of 80 myopic subjects and controls who were chosen among the subjects who routinely referred to the outpatient department of our ophthalmology clinic. Sex of the subjects were set as to be distributed equally (40 males and 40 females). Each group consisted of 40 eyes of 20 subjects.

Four groups were formed according to their refraction. The refractive parameters of the subjects were as follows:

Group 1(Control group): Between 0.00 and -0.75 D.
Group 2(Low grade myopia): Between -1.00 and -3.00 D
Group 3(Medium grade myopia): Between -3.25 and -6.00 D
Group 4 (High myopia): Between -6.25 and – 10.00 D.

All the myopic subjects and the controls underwent a complete ophthalmological examination including an anterior segment examination and intraocular pressure measurements were recorded.

Inclusion criteria were as follows: (I) A best corrected visual acuity equal or not less than 0.7 (II) age between 18 and 40 years of age [since PERG results are likely to be affected by aging (7)] (III) refraction between 0.00 and -10.00 (since PERG results may be affected from the chorioretinal atrophy of the subjects with a refraction higher than – 10.00)

Exclusion criteria were as follows: (I) any media opacities (cataract, vitreus opacities, corneal opacities etc.), (II) any ocular disease apart from refractive errors (optic nerve, retina etc.) that may affect electroretinographic evaluation, (III) myopic degeneration (IV) subjects with a refraction higher than – 10.00D. (V) subjects receiving systemic treatment that may affect electroretinographic evaluation.

PERG Recording. The checkerboard transient PERG was recorded with Tomey Primus 2.5 (Tomey GmbH, Erlangen, Germany) in accordance with the guidelines of the International Society for Clinical Electrophysiology of Vision (ISCEV) (3). Gold foil recording electrodes were placed in the fornix of the lower eyelid and referred to ipsilateral outer canthus silver-silver chloride electrodes with a mid forehead earth. During PERG recordings, bandpass filters amplifiers included the range from 1 to 100 Hz. Stimulus was applied as alternating checkerboards. Contrast between the alternating checkerboards was set to 80 %. Frequency of stimulation was 1.22/sec, stimulations per minute was 73.2, acquisition time was 204 msecs, number of reversals was set at 150. The distance between the patient's eyes and the monitor was 30 cm. Stimulus field size was 15x 15.

The test was performed binocularly to facilitate fixation with undilated pupils and spectacle correction was used when appropriate. The effects of blink artefact were minimized by instructing the patient not to blink while the pattern was moving when needed stimulation was interrupted, the patient allowed to blink few times, and stimulation resumed after signal stabilization. In the recording session, PERGs were recorded at least twice and the resulting waveforms were superimposed to check the repeatability of the results.

Myopics and the controls were informed with regard to the nature of the study; informed consent was obtained from each subject prior to the examination. The assessor of the PERG waveforms was blind to the nature of the study and identity of the subjects.

Statistical Analysis. All statistical analysis was performed using SPSS 10.0 for Windows (SPSS Inc, Chicago, IL, USA). A *p* value of 0.05 or less was considered statistically significant. Axial lengths, refraction values, amplitude and latencies of P50 and N95 waves were used in statistical calculations. One way ANOVA test was used for the statistical analysis. Pearson's correlation analysis was used for correlation analysis between the variables. The n value was for the subjects.

Results

In each group, age, refractive values, axial length, P50 and N95 amplitudes and latencies were compared between men and women; there was not a statistically significant difference between the groups (p >0.05). There was not a statistically significant difference between variables of left and right eyes, therefore eyes were evaluated together.

Age, refraction values and average axial length of all groups are shown on Table I.

Average amplitude and latencies of P50 and N95 waves were determined and ANOVA test was used to search the statistical relationship between the groups. When P50 and N95 wave amplitudes were analysed, there was a statistically significant difference between group 1 compared with groups 3 and 4; group 2 compared with groups 3 and 4; and group 3 compared with group 4 (p<0.05), but there was not a statistically significant difference between group 1 compared with group 2 (p=0.142). When P50 and N95 wave latencies were analysed, there was not a statistically significant difference between all groups (P50: p=0.566; N95: p=0.273) (Table 1).

Table I. Mean Values for Age, Refractive Error, Axial Lengths, P50 and N95 Wave Amplitude and Latencies of Subjects in All Groups.

	Group 1 (controls)	Group 2 (low grade myopes)	Group 3 (Medium grade myopes)	Group 4 (High myopes)	F
Age (years)	25.60±5.11	25.35±4.19	27.45±5.09	27.75±4.48	1.33
Refractive error (D)	-0.41±0.21	-2.15 ±0.53	-4.34±0.612	-8.81 ±1.08	505.86*
Axial Length (mm)	23.44±0.66	24.10±0.71	24.93±0.58	26.95±1.18	138.29*
P50					
Amplitude(µV)	5.55±1.33	5.07±0.81	3.72±0.89	3.18±0.72	52.83*
Latency (ms)	49.95±2.60	50.45±2.69	50.67±1.94	50.18±2.41	0.66
N95					
Amplitude(µV)	9.67±2.59	8.88±1.39	7.65±1.15	5.15±1.05	56.25*
Latency (ms)	92.40±5.35	92.85±5.54	92.65±0.52	95.08±4.19	2.78

Data were given as mean ±SD. *p=0.000. PostHoc Test: When P50 and N95 wave amplitudes were analysed, there was a statistically significant difference between groups 1 compared with groups 3 and 4; group 2 compared with groups 3 and 4; and group 3 compared with group 4 (p=0.000). D: Diopter; mV: microvolt; ms: millisecond.

Pearson's correlation coefficient was used to analyse the relationship between refraction and the axial length. There was a statistically significant negative correlation. (p<0.05; r=0.82). When P50 and N95 amplitudes were correlated to refractive errors, it was found that the more negative the refraction error was, the less were the amplitudes of P50 (p<0.05, r^2 =0.33) and N95 (p<0.05, r^2 = 0.30) values.

A
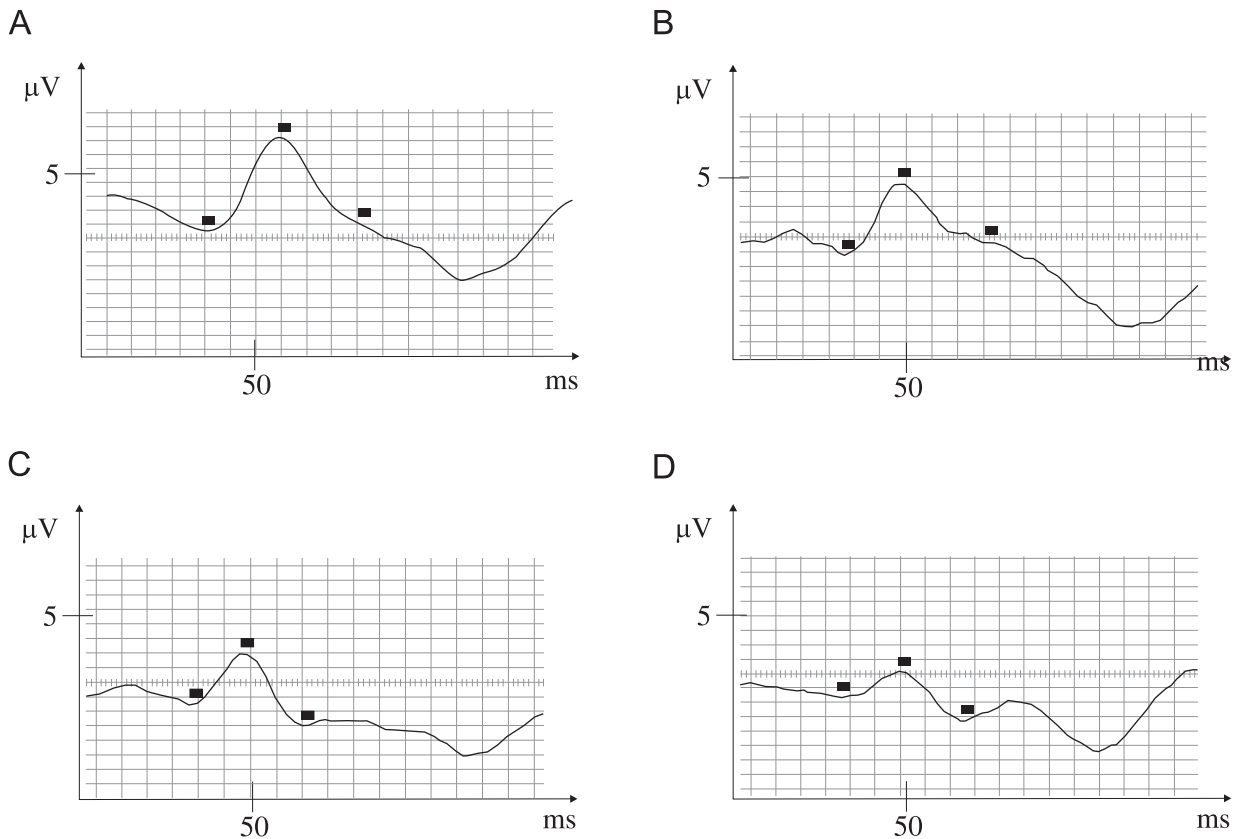

B

C

D

Fig. 1. The layouts of PERG obtained from individual subjects of each group; 1A. group 1 1B. group 2; 1C. group 3; and 1D. group 4. Note the decrease in P 50 and N 95 amplitudes in group 2 and 3. Calibrations for PERG recordings were made according to the guidelines of the International Society for Clinical Electrophysiology of Vision (ISCEV) as described in the methods.

Discussion

In myopia ıt is thought that thinning in the macular region is due to loss of the ganglion cell layer (8). In a study by Ozdek et al, nerve fiber layer thickness in myopic subjects was measured by scanning laser polarimetry. Upper quadrant nerve fiber thickness was 15.5% thinner than the control group whereas lower quadrant nerve fiber layer thickness was 10.8% thinner than the controls. There was a linear correlation between the thinning of the nerve fiber layer and the degree of the myopic error (9).

Electrophysiologic studies in myopic eyes attracted attention during the last few years; these studies showed that when the myopic error increased, ERG potentials also showed a decrease. Multifocal, flash and pattern ERG studies also supported this evidence (10, 11).

Flash ERG studies in high myopic eyes showed that there was a decrease in photopic, scotopic a and b wave amplitudes (12-14). There are some studies indicating electrophysiologic changes in low myopes without a significant pathology (15, 16).

Since PERG shows functional status of retinal ganglion cells, it has been widely used to evaluate anterior optic pathways. PERG abnormalities have been demonstrated in optic nerve and macular dysfunctions (1, 2).

The findings obtained from the study by Hidayat et al (5), indicated a significant negative correlation between the axial lenght of normal eyes and the PERG P50 amplitude. Therefore the increased axial length may contribute to the decrease in PERG amplitudes in our study.

There are several studies regarding PERG findings in myopic eyes (4, 6). In one of these studies, Varano evaluated macular function after PDT in myopic maculopathy with ERG and PERG. The findings of this study showed significant increase in the amplitudes of ERG and PERG after PDT in myopic maculopathy (6).

In an other study, Lubinski evaluated PERG recordings of 60 eyes of 30 subjects who had myopia ranging between - 4 and -8 D. He compared the findings with 30 control eyes. He demonstrated that in 30% of myopic eyes, there was a low amplitude. He emphasized that this low amplitude may have a prognostic value. Latencies were not studied in this study (4).

Our study differed from that of Lubinski's by several ways. In Lubinski's study the myopic eyes which ranged between -4 / -8 D were not further divided into subgroups; we, on the other hand sub divided our subjects who ranged between –1 and –10.00 D and compared with controls. This allowed us to make a comparison between the subgroups.

Another difference is between the methods. Lubinski used steady state while we used transient PERG. In steady state PERG, the frequency of steady state PERG is greater than transient PERG and the wave obtained is in a sinusoidal shape. Therefore it is not possible to use P50 and N95 waves separately. Only the wave peak between the two waves can be calculated. On the other hand, transient state allows us to evaluate the two waves separately. In our study, mean latencies of P50 and N95 waves did not show pathological latency prolongation.

Decreased P50 amplitude indicates a macular functional disorder in subjects with high myopia who had near normal visual acuity. N95 amplitude decrease shows ganglion cell dysfunction. PERG recordings obtained in our study shows that macular as well as ganglion cell functional disorder contribute to decreased visual acuity in myopia. The mechanism by which axial myopia in the absence of dejenerative changes affects macular function as well as ganglion cells is as yet not clear. Our study is a preliminary one; it is also evident from our study that PERG recordings must be carefully evaluated when the study group in any study could involve myopic subjects.

References

1.Holder GE. Pattern electroretinography (PERG) and an integrated approach to visual pathway diagnosis. Prog Retin Eye Res 2001;20: 531-561.

2.Holder GE. The pattern electroretinogram in anterior visual pathway dysfunction and its relationship to the pattern visual evoked potential: a personal clinical review of 743 eyes. Eye 1997;11: 924-934.

3.Holder GE, Brigell MG, Hawlina M, Meigen T, Vaegan, Bach M; International Society for Clinical Electrophysiology of Vision ISCEV standard for clinical pattern electroretinography--2007 update.. Doc Ophthalmol 2007;114: 111 -116.

4.Lubinski W. Electroretinogram of the ''pattern'' type of eyes with medium grade myopia (Polish). Klin Oczna 1991; 93: 284 -285.

5.Hidajat R, Mclay J, Burley C, Elder M, Morton J, Goode D. Influence of axial length of normal eyes on PERG. Doc Ophthalmol. 2003; 107: 195 -200.

6.Varano M, Parisi V, Tedeschi M, et al. Macular function after PDT in myopic maculopathy: psychophysical and electrophysiological evaluation. Invest Ophthalmol Vis Sci 2005; 46: 1453 -1462.

7.Porciatti V, Burr DC, Morrone MC, Fiorentini A. The effects of aging on the pattern electroretinogram and visual evoked potential in humans. Vision Res. 1992;32: 1199-1209.

8.Okabe S, Matsuo N, Okamoto S, Kataoka H. Electron microscopic studies on retinochoroidal atrophy in human eye. Acta Med Okayama 1982; 36:11-21.

9.Ozdek C, Onol M, Gürelik G, Hasanreisoglu B. Scanning laser polarimetry in normal subjects and patients with myopia. Br J Ophthalmol 2000; 84: 264-267.

10.Uchida A. Studies on electrical activities of the eye in high myopia (Japanese). Nippon Ganka Gakkai Zasshi 1987; 81: 1328-1350.

11.Kawabata H, Adachi-Usami E. Electrophysiological changes of photopic function in myopia. In: Tokoro T, ed. Proceeding of the Sixth International Conference on Myopia, Hakone, 1996, Myopia Update. Springer-Verlag: Tokyo; 1997: 388 -393.

12.Perlman I, Meyer E, Haim T, Zonis S. Retinal function in high refractive error assessed electroretinographically. Br J Ophthalmol 1984; 68: 79-84.

13.Pallin O. Influence of axial length of the eye on the size of the recorded b- potential in the clinical single-flash electroretinogram. Acta Ophthalmol 1969; 47: 1-57.

14.Chen JF, Elsner AE, Burns SA et al. The effect of eye shape on retinal responses. Clin Vision Sci 1992; 6: 521-530.

15.Ishikawa M, Miyake Y, Shiroyama T. Focal macular electroretinogram in high myopia (Japanese). Nippon Ganka Gakkai Zasshi 1990; 94:1040-1027.

16.Kawabasa H, Muroyama K, Adachi-Usame E. Multifocal electroretinogram as a function of degree of myopia. Report 2. Folia Ophthalmol Jpn 1996; 47:509-513.