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Features of retinal bioelectrical activity in the fellow eye of patients with rhegmatogenous retinal detachment associated with choroidal detachment

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Purpose: *To determine, based on full-field electroretinogram (ffERG) data, the features of bioelectrical activity in the fellow eye of moderate and high myopes with rhegmatogenous retinal detachment (RRD) associated with choroidal detachment (CD) (RRD+CD).*

Material and Methods: Fifty-two fellow eyes were examined three months after surgery for RRD in the first eye (32 eyes with RRD only and 20 eyes with RRD+CD). A group of 14 normal individuals (28 eyes) was used as a control group. Patients underwent ophthalmological examination and International Society for Clinical Electrophysiology of Vision (ISCEV) ffERG testing.

Results: *The severity of myopia and the presence of CD in the affected eye were found to be the factors that influenced the dark-adapted (DA) 0.01 ERG b-wave amplitude ($F = 3.83$, $p = 0.01$ and $F = 5.0$, $p = 0.03$, respectively) and DA 3.0 ERG b-wave amplitude ($F = 4.65$, $p = 0.012$ and $F = 9.18$, $p = 0.005$, respectively). In the fellow eye of RRD+CD patients, light-adapted (LA) 3.0 ERG a-wave and b-wave peak times were by 14% longer ($p = 0.005$), and by 12.3% longer ($p < 0.05$), respectively, compared to the controls. The presence of CD in the affected eye was found to be a factor that influenced the LA 3.0 ERG a-wave peak time ($F = 10.2$, $p = 0.003$): the peak time in the fellow eye for high myopes with RRD+CD was by 19% longer than for those with RRD only. The presence of myopia in the affected eye was found to be a factor that influenced the LA 3.0 ERG b-wave amplitude ($F = 3.02$, $p = 0.042$): compared to the controls, the b-wave amplitude in the fellow eye was reduced by 32.5% ($p = 0.01$) for high myopes with RRD only, and by 40% ($p = 0.005$) for those with RRD+CD.*

Conclusion: *We found substantial difference between groups of myopes with RRD+CD and groups of myopes with RRD only in terms of electrical activity of the peripheral retina (the rod photoreceptor layer and layers of inner retinal bipolar cells) in the fellow eye. Based on the findings of our study of the fellow eye in patients with a severity of myopia in the fellow eye being similar to that in the first eye, it may be hypothesized that CD develops in RRD patients with more severe abnormalities in ERG.*

Key words:

retinal detachment, choroidal detachment, electroretinography, myopia, retinal degeneration

Introduction

Rhegmatogenous retinal detachment (RRD) complicated by (or associated with) choroidal detachment (CD) (RRD+CD) is a severe eye disease whose visual prognosis and outcome after treatment remain poor despite substantial advances in surgical technologies. The presence of a severe CD makes visualization and identification of causative retinal breaks more difficult, potentially leading to misdiagnosis of primary RRD [1, 2, 3], with a rate of postoperative proliferative chorioretinopathy as high as 35.4–52.4% significantly increasing the risk of retinal re-detachment [4, 5].

The pathogenesis of CD in eyes with in RRD is not clear but hypotony, initiated by the RRD may play an important role in its development. In response to the hypotony the choroidal arterioles will dilate, which results in transudation of protein rich fluid into choroidal and suprachoroidal space. This will lead to further edema and detachment of the ciliary body enhancing the process [3, 6]. Increased ocular inflammation is also believed to be involved in the development of CD [7, 8].

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High myopia, aphakia or pseudophakia, senior age and posterior retinal tears (especially macular holes) have been established as risk factors for CD in the presence of primary RRD [6, 9, 10, 11].

Despite the established risk factors, there is still a lack of understanding in which primary RRD cases CD will and will not develop. It has been hypothesized that a potential difference in the severity of alterations in blood supply to the retina between RRD only and RRD+CD might play a role [8]. It is possible that CD develops in the RRD individuals exhibiting more severe dystrophic changes in eyes that are morphologically prone to this complication. This hypothesis is favored by the fact that RRD+CD has been more frequently seen in eyes with high myopia [11] that is accompanied by structural and functional changes in the posterior segment [12]. Retinal trophic abnormalities in axial myopia have been confirmed by electroretinography [13, 14]. Additionally, the prevalence of high myopia in China is extremely high [15], with the incidence of CD occurring with primary RRD for that country being as high as 18.9% compared to 0.2-4.5% for Caucasians [9].

The retinal function can be assessed by electrophysiological tests that study the electric properties of the biological tissues, driven by the flow of ions [16, 17].

The elecroretinogram (ERG) with the standard protocol by the International Society for Clinical Electrophysiology of Vision (ISCEV) is widely used to determine the global and localized retinal responses [18, 19]. When a bright flash of light illuminates the retina, changes in membrane potentials across the neuronal and non-neuronal retinal cells simultaneously and instantaneously give rise to an extracellular current, which forms the basis of ERG [20, 21]. By varying the background illumination, the light- or dark-adapted state of the eye, and the intensity of stimulus flash, one can elicit and isolate responses from different retinal cells. Hence, the ERG test provides a unique opportunity to investigate changes in retinal electrical activity in several diseases or ocular conditions including refractive errors [18, 22, 23, 24].

Given the above, we considered it appropriate to compare the fellow eye of patients with RRD only to that of patients with RRD+CD in terms of retinal bioelectrical activity.

The purpose of the study was to use the full-field ERG (ffERG) to assess the retinal bioelectrical activity in the fellow eye of patients with RRD associated with CD.

Material and Methods

Fifty two fellow-eyes of 52 patients were included in the study three months after successful surgery for RRD only (32 patients (32 eyes)) or RRD+CD (20 patients (20 eyes)) in the first eye. In all patients, RRD developed in the presence of moderate myopia (3.25–6.0 D) or high myopia (> 6.0 D). Refractive errors in the fellow eye were similar to those in the operated eye, and, in all patients, both eyes exhibited peripheral retinal degeneration.

Patients were divided into four groups: group 1 of 21 moderate myopes with RRD only, group 2 of 11 high myopes with RRD only, group 3 of 9 moderate myopes with RRD+CD, and group 4 of 11 high myopes with RRD+CD. There was no significant difference between groups of patients with RRD only and groups of patients with RRD+CD in terms of the length of RRD duration (19.2 ± 8.3 and 17.5 ± 13.2 days, respectively), type of surgery (vitrectomy, retinal laser photocoagulation, and perfluoropropane tamponade) or age (53.8 ± 17 years).

A group of 14 individuals (28 eyes) of a similar age to patients, and having no systemic or eye disease was used as a control group.

The study involved human subjects, and followed the ethical standards stated in the Declaration of Helsinki, European Convention on Human Rights and Biomedicine, and relevant Ukrainian legislation in force. Written informed consent was obtained from all participants, and measures were taken to ensure anonymity.

The clinical ophthalmological examination included visual acuity, refractometry, keratometry, tonometry, biomicroscopy, ophthalmoscopy of the dilated eye, ocular axial length [AL] measurement, threshold electrical sensitivity of the optic nerve (ESON), critical frequency of phosphene disappearance (CFPD) and Humphrey 24-2 Swedish Interactive Thresholding Algorithm (SITA) visual field testing using the standard automated perimetry Humphrey Field Analyzer 750i (HFA; Carl Zeiss Meditec, Dublin, CA, USA). Optical coherence tomography (OCT) of the macula, optic disc and peripupillary retina were performed, if required, to clarify the diagnosis.

Operated and fellow eyes were assessed for bioelectric retinal activity. An ffERG examination was performed using the electrophysiological test unit Retiscan (Roland Consult, Wiesbaden, Germany) according to ISCEV Standard for clinical ERG [25]. The ISCEV Standard specifies five responses:

(1) Dark-adapted (DA) 0.01 ERG (a rod-driven response of on bipolar cells);

(2) DA 3.0 ERG (combined responses arising from photoreceptors and bipolar cells of both the rod and cone systems; rod dominated);

(3) DA 3.0 oscillatory potentials (responses primarily from amacrine cells);

(4) Light-adapted (LA) 3.0 ERG (responses of the cone system; a-waves arise from cone photoreceptors and cone Off-bipolar cells; the b-wave comes from On- and Off-cone bipolar cells);

(5) LA 30 Hz flicker ERG (a sensitive cone-pathway-driven response).

A jet electrode was used as the active electrode and placed on the patient's eye after topical anesthetic was ap-

plied, followed by 20 min dark adaptation. The gold cup skin electrodes were used as reference and ground ones. Electrodes were placed and ERG was recorded according to the ISCEV Standard [19, 25].

ERG a-wave and b-wave amplitudes and peak times were assessed.

Statistical analyses were conducted IBM SPSS Statistics. The normal distribution of data was tested using the Kolmogorov–Smirnov test. Nominal data are presented as numbers and percentage. The mean (M) and standard deviation (SD) values were calculated for normally distributed data. Student's t test was used to compare the means of two samples. The median (interquartile range (IQR)) values were calculated for non-normally distributed data. Mann-Whitney U test was used for the comparison of two samples when the underlying distributions were not normal. The level of significance $p \leq 0.05$ was assumed.

Results

Best-corrected visual acuity (BCVA) for the non-operated fellow eye was substantially lower in high myopes with RRD+CD than in moderate myopes. There was, however, no significant difference in BCVA for the non-operated fellow eye between moderate myopes with RRD+CD and those with RRD only, and between high myopes with RRD+CD and those with RRD only.

In the retina of moderately or highly myopic eyes, DA 0.01 ERG b-wave amplitude was somewhat lower compared to a normal retina in controls, but the difference was statistically significant only for the fellow eye in high myopes with RRD+CD ($p = 0.006$) (Table 2). The severity of myopia and the presence of CD in the affected eye were found to be the factors that influenced the DA 0.01 ERG b-wave amplitude ($F = 3.83$, $p = 0.01$ and $F = 5.0$, $p = 0.03$, respectively).

Table 1. Visual acuity in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD) (M±SD)

	Group	n	Uncorrected visual acuity	Best-corrected visual acuity
Fellow eye (affected eye having RRD only)	1	21	0,22±0,23	0,82±0,14
	2	11	0,06±0,04	0,50±0,24
Fellow eye (affected eye having RRD+CD)	3	9	0,24±0,21	0,72±0,26
	4	11	0,07±0,08	0,53±0,07

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 2. Dark-adapted 0.01 ERG b-wave amplitude in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Amplitude (μV)	
			Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	96.9	61.5 – 108
	2	11	54.2	26.7 – 91.5
Fellow eye (affected eye having RRD+CD)	3	9	81.9	22.0 – 139.0
	4	11	30.1	25.6 – 33.5
Controls	5	28	121.5	74 – 150
P-value			$P_{4-5} = 0.006$; $P_{2-3} = 0.05$	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; n, number of eyes; RRD, rhegmatogenous retinal detachment

DA 3.0 ERG is combined responses from photoreceptors and bipolar cells to a flash strength of 3.0 cd s m-2 and reflects the bioelectrical activity of the outer and middle layers of the retina (predominantly the peripheral retina). No significant differences were observed between any of the study groups and the control group, and between any two study groups in terms of the DA 3.0 ERG a-wave peak time (the measure of rod photoreceptor function) (Table 3).

Compared to the controls, the DA 3.0 ERG a-wave amplitude in the fellow eye was substantially reduced (46.5% reduction (p = 0.005) for high myopes with RRD only (group 2), and 42.3% reduction (p = 0.04) for those with RRD+CD (group 4)). In addition, compared to controls, there was a 44.4% reduction in the photoreceptor activity in the fellow eye for the total high myopes. The severity of myopia was found to be the factor that influenced the DA 3.0 ERG a-wave amplitude (F = 5.5, p = 0.0003).

The DA 3.0 ERG b-wave reflects the bioelectrical activity of the rod bipolar cells and Müller cells of the inner peripheral retina. No significant differences were observed between any of the study groups and the control group in terms of the DA 3.0 ERG b-wave peak time (Table 4). However, compared to the controls, DA 3.0 ERG b-wave amplitude in the fellow eye was reduced by 33.6% (p = 0.002), 40.7% (p = 0.007), and 41.5% (p = 0.002), respectively, in groups 2, 3, and 4, respectively. The severity of myopia and the presence of CD in the affected eye were found to be the factors that influenced the DA 3.0 ERG b-wave amplitude (F = 4.65, p = 0.012 and F = 9.18, p=0.005, respectively).

OPs reflect the bioelectrical activity of the inner retinal cells (primarily amacrine cells). Mean (±SD) OP1

Table 3. Dark-adapted 3.0 ERG a-wave amplitude and peak time in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Peak time (ms)	Amplitude (μV)	
			M±SD	Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	22.4 ± 2.1	157	102 – 167
	2	11	23.5 ± 2.8	91.3	68 – 110
Fellow eye (affected eye having RRD+CD)	3	9	23.2 ± 1.7	130	129 – 141
	4	11	22.5 ± 1.9	98	60 – 150
Controls	5	28	20.2 ± 2.7	170	144 – 203
P-value			–	P_{4-5} = 0.04; P_{2-5} = 0.005; P_{2-3} = 0.014	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 4. Dark-adapted 3.0 ERG b-wave amplitude and peak time in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Peak time (ms)	Amplitude (μV)	
			M±SD	Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	46.1±6.9	377	276 – 428
	2	11	50.0±3.4	262	226 – 302
Fellow eye (affected eye having RRD+CD)	3	9	42.0±8.1	234	213 – 280
	4	11	42.2±7.9	231	185 – 285
Controls	5	28	44.7±1.3	395	374 – 435
P-value			–	P_{2-5}=0.002; P_{3-5}=0.001; P_{4-5}=0.002	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 5. Dark-adapted 3.0 oscillatory potentials in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Time (ms)	Amplitude (μV)
			M±SD	M±SD
Fellow eye (affected eye having RRD only)	1	21	23.5±3.5	29.1±8.3
	2	11	24.4±3.1	20.0±7.9
Fellow eye (affected eye having RRD+CD)	3	9	22.2±2.8	24.0±7.5
	4	11	22.2±1.8	28.7±12.0
Controls	5	28	21.0±1.2	44.9±13.6
P-value			P_{2-5}=0.002	P_{1-5} = 0.017; P_{2-5} = 0.0007; P_{3-5}=0.002; P_{4-5}=0.015

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 6. Light-adapted 3.0 ERG a-wave amplitude and peak time in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Peak time (ms)	Amplitude (μV)	
			M±SD	Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	16.8±0.8	20.5	9.8 – 31.4
	2	11	17.7±1.3	14.8	11.2 – 16.5
Fellow eye (affected eye having RRD+CD)	3	9	19.0±3.5	20.98	17.8 – 25.0
	4	11	21.0±4.1	22.3	16.2 – 28.5
Controls	5	28	16.5±1.2	23	21 – 27
P-value			P_{2-5}=0.03; P_{3-5}=0.008; P_{4-5}=0.003	P_{2-5}=0.02	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 7. Light-adapted 3.0 ERG b-wave amplitude and peak time in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD)

	Group	n	Peak time (ms)	Amplitude (μV)	
			M±SD	Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	34.8±2.2	57	54 – 93
	2	11	34.8±4.3	54	42 – 66
Fellow eye (affected eye having RRD+CD)	3	9	31.4±2.8	68	58 – 75
	4	11	33.7±12.3	48	43 – 51
Controls	5	28	32.6±1.2	80	74 – 109
P-value			P_{2-5}=0.04; P_{3-5}=0.013; P_{4-5}=0.007	P_{2-5}=0.01; P_{3-5}=0.06; P_{4-5}=0.005	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M±SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

Table 8. Light-adapted 30 Hz flicker ERG amplitude in the fellow eye of patients with rhegmatogenous retinal detachment (RRD) only versus RRD associated with choroidal detachment (RRD+CD) in the first eye

	Group	n	Amplitude (μV)	
			Median	Interquartile range
Fellow eye (affected eye having RRD only)	1	21	36	33 – 90
	2	11	39	36 – 49
Fellow eye (affected eye having RRD+CD)	3	9	45,6	43 – 50
	4	11	40	36 – 46
Controls	5	28	51	40 – 60
P-value			P>0,05	

Note: CD, choroidal detachment; ERG, electroretinogram; groups 1 and 3, moderate myopia; groups 2 and 4, high myopia; M ± SD, mean ± standard deviation; n, number of eyes; RRD, rhegmatogenous retinal detachment

peak time in the fellow eye of patients with RRD of the four groups was 24.4 ± 3.2 ms, which was by 16% longer ($p = 0.004$) than for the controls. Compared to the controls, the OP amplitude in the fellow eye was substantially reduced (35.1% reduction ($p = 0.003$) for group 1, 55.4% reduction ($p = 0.0017$) for group 2, 46.5% reduction ($p=0.002$) for group 3, and 36% reduction ($p = 0.015$) for group 4) (Table 5). There was no significant difference between group 1 and group 3, and between group 2 and group 4, in terms of the OP amplitude or OP peak time in the fellow eye.

LA 3.0 ERG reflects the function of cone photoreceptors (a-wave) and cone bipolar cells and Müller cells (b-wave) of the outer and inner central retina. Mean (±SD) LA 3.0 ERG a-wave peak time in the fellow eye for all the four groups was 18.8 ± 3.0 ms (Table 6), which was by 14% longer, compared to the controls ($p = 0.005$). Additionally, the LA 3.0 ERG a-wave peak time in the fellow eye for high myopes with RRD+CD (group 4) was by 19% longer than for high myopes with RRD only (group 2). The presence of CD in the affected eye was found to be a factor that influenced the LA 3.0 ERG a-wave peak time ($F = 10.2$, $p = 0.003$). Mean (± SD) LA 3.0 ERG b-wave peak time in the fellow eye for all the four groups was by 12.3% longer, compared to the controls ($p < 0.05$).

Compared to the controls, the LA 3.0 ERG b-wave amplitude in the fellow eye was substantially reduced (32.5% reduction ($p = 0.01$) for high myopes with RRD only (group 2), and 40% reduction ($p = 0.005$) for high myopes with RRD+CD (group 4)) (Table 7). There was also a tendency for reduction in the LA 3.0 ERG b-wave amplitude in the fellow eye in moderate myopes with RRD+CD (group 3) ($p = 0.06$). The presence of myopia in the affected eye was found to be a factor that influenced the LA 3.0 ERG b-wave amplitude ($F = 3.02$, $p = 0.042$).

LA 30 Hz flicker ERG reflects the central retinal rod function, and the LA 30 Hz flicker ERG in the fellow eye of patients with RRD of the four groups was not significantly different from the controls (Table 8).

Discussion

High myopia is believed to be a substantial risk factor for CD in eyes with primary RRD [9, 10, 11]. In a study by Yu and colleagues [11], when compared with patients with longer AL (AL ≥ 24 mm), the incidence of CD among RRD patients was significantly lower ($P = 0.011$) in patients with lower AL (AL < 24 mm). They believed that with increasing AL in high myopia, retinal and choroidal tissues, including retinal pigment epithelium (RPE), will suffer from traction and trophic degeneration. Meanwhile, liquefied vitreous can enter into the subretinal space through the retinal breaks to form a large amount of subretinal fluid (SRF). SRF absorption facilitated by the RPE pump will result in severe hypotony in retinal detachment during high myopia. In addition, fundus degeneration decreases the ability of choroidal blood vessels to counter the changes of IOP. Hypotony induced by retinal detachment is more likely to cause increased flow of choroidal vessels, slower blood flow, flow stasis, and a further increase in CD [9]. The severity of ERG abnormalities has been demonstrated to increase with the severity of myopia and dystrophic changes in the fundus. Fitcroft and colleagues [24] evaluated the relation between refractive errors and ERG abnormalities in children (mean age, 7.1 years) referred for investigation of reduced vision. The incidence of abnormality was higher in high ametropes (52%) compared to the other groups (23.5%), and the highest inci-

dence (53.3%) was seen in high myopes (≥ 6.00 D) versus 26% in moderate or low myopes [24]. Studies [26, 27, 28, 29, 30] have demonstrated that there was a substantial difference among groups with various severity of myopia in terms of ffERG a-wave and b-wave amplitudes, with a significantly reduced b-wave amplitude under scotopic and photopic conditions in high myopes; however, abnormalities in scotopic responses (DA 3.0 ERG) were more pronounced than those in photopic responses (LA 3.0 ERG and LA 3.0 flicker). In a study by Ishikawa and colleagues, highly myopic eyes were divided into those showing only tigroid fundus (group 1) and those associated with posterior staphyloma involving the macula (group 2) [31]. The a-wave and b-wave amplitudes in group 1 were significantly smaller than normal, and the a-wave, b-wave and OP amplitudes in group 2 were significantly smaller than those in group 1 [31]. It is believed that chorioretinal vascular abnormalities and RPE and photoreceptor degeneration play an important role in the presence of such ERG responses in high degenerative myopia [32].

All our study patients were moderate to high myopes with a refractive error in the eye with RRD being the same as in the fellow eye. The ERG of the intact fellow eye was performed three months after successful surgery for RRD in the first eye. On the basis of these ERG studies, we found that the severity of myopia had a substantial influence on the electrical activity of the outer layers (photoreceptor cells) and inner layers (bipolar cells and Müller cells) of the peripheral and central retina. That is, in highly myopic eyes, b-wave amplitude of DA 0.01 ERG, a-wave and b-wave amplitudes of DA 3.0 ERG, and b-wave amplitude of LA 3.0 ERG a-wave were lower than in moderately myopic eyes. Our findings are in agreement with literature reports on the relationship between ERG parameters and the severity of myopia [14, 26, 28, 29, 30].

Additionally, we found relationship between some ERG parameters for the fellow eye and the presence of RRD+CD in the first eye. Thus, in the fellow eye of patients that had RRD+CD, b-wave amplitudes of DA 0.01 ERG and DA 3.0 ERG were lower than in the fellow eye of patients that had RRD only in the first eye. Compared to controls, a 41% reduction in the b-wave amplitude of DA 3.0 ERG was observed in the fellow eye of both moderate and high myopes that had RRD associated with CD in the first eye. However, a 33% reduction in the b-wave amplitude of DA 3.0 ERG was observed in the fellow eye of high (but not moderate) myopes that had RRD only in the first eye. This indicated that middle retinal lesions were more severe in patients that had RRD+CD in the first eye.

Moreover, compared to controls, a 44% reduction in the a-wave amplitude of DA 3.0 ERG was observed in the fellow eye of high (but not moderate) myopes that had RRD (either uncomplicated or complicated by CD) in the first eye. LA 3.0 ERG reflects the function of the outer and inner central retina. High myopes with RRD+CD in the first eye exhibited a longer LA 3.0 ERG a-wave peak time in the fellow eye compared to patients in other groups.

In general, we found substantial difference between groups of myopes with RRD+CD in the first eye and groups of myopes with RRD only in the first eye in terms of electrical activity of the peripheral retina (the rod photoreceptor layer and layers of inner retinal bipolar cells), indicating that CD may develop in the presence of more severe chorioretinal dystrophic changes in high myopes with RRD.

This may be explained by the results of regional hemodynamic studies in such eyes. Our ophthalmic rheography study [33] found that volumetric ocular pulse blood filling values in the affected eye and fellow eye for patients with RRD+CD were 68.7% and 40%, respectively, lower, and for patients with RRD only, 33.3% and 27%, respectively, lower, than in age-matched normals. These findings indicate substantial alterations in blood supply to the retina in eyes with RRD (especially those with RRD+CD) [33] and may lay the ground for developing pathogenetic treatment preceding and/or following surgery for retinal detachment.

In conclusion, we found substantial difference between groups of myopes with RRD+CD and groups of myopes with RRD only in the first eye in terms of electrical activity of the peripheral retina (the rod photoreceptor layer and layers of inner retinal bipolar cells) in the fellow eye. This finding indicates that the former type of patients had more severe chorioretinal dystrophic changes. Based on the findings of our study of the fellow eye in patients with a severity of myopia in the fellow eye being similar to that in the first eye, it may be hypothesized that CD develops in RRD patients with more severe abnormalities in ERG.

References

1. Sharma T, Challa JK, Ravishankar KV, Murugesan R. Scleral buckling for retinal detachment. Predictors for anatomic failure. Retina. 1994;14(4):338–43.
2. Burton TC. Preoperative factors influencing anatomic success rates following retinal detachment surgery. Transact Sec Ophthalmol Am Acad Ophthalmol Otolaryngol. 1977;83(3 Pt 1):OP499–505.
3. De Smedt S, Sullivan P. Massive choroidal detachment masking overlying primary rhegmatogenous retinal detach¬ment: a case series. Bull Soc Belge Ophtalmol. 2001; 282: 51-55.
4. Girard P, Mimoun G, Karpouzas I, Montefiore G. Clinical risk factors for proliferative vitreoretinopathy after retinal detachment surgery. Retina. 1994; 14: 417-424.
5. Li Z, Li Y, Huang X, Cai XY, Chen X, Li S, Huang Y, Lu L. Quantitative analysis of rhegmatogenous retinal detachment associated with choroidal detachment in Chinese using UBM. Retina. 2012;32(10):2020–5.

6. Kang JH, Park KA, Shin WJ, Kang SW. Macular hole as a risk factor of choroidal detachment in rhegmatogenous retinal detachment. Korean J Ophthalmol. 2008;22(2):100–3.
7. Wei Y, Wang N, Chen F, et al. Vitrectomy combined with periocular/intravitreal injection of steroids for rhegmatogenous retinal detachment associated with choroidal detachment. Retina. 2014; 34(1): 136–14.
8. Alibet Y, Levystka G, Umanets N, Pasyechnikova N, Henrich PB. Ciliary body thickness changes after preoperative anti-inflammatory treatment in rhegmatogenous retinal detachment complicated by choroidal detachment. Graefe's Arch. Clin. Exp. Ophthalmol. 2017. 255(8): 1503–1508.
9. Seelenfreund MH, Kraushar MF, Schepens CL, Freilich DB. Choroidal detachment associated with primary retinal detachment. Arch Ophthalmol. 1974;91(4):254–8.
10. Rahman N, Harris GS. Choroidal detachment associated with retinal detachment as a presenting finding. Can J Ophthalmol. 1992;27(5):245–8.
11. Yu Y, An M, Mo B et al. Risk factors for choroidal detachment following rhegmatogenous retinal detachment in a chinese population. BMC Ophthalmol. 2016; 16: 140. https://doi.org/10.1186/s12886-016-0319-9.
12. Wong YL, Ding Y, Sabanayagam C et al. Longi¬tudinal changes in disc and retinal lesions among highly myopic adolescents in Singapore Over a 10-Year period. Eye Contact Lens. 2018; 44:286-291.
13. Zahra S, Murphy MJ, Crewther ShG, Riddell N. Flash Electroretinography as a Measure of Retinal Function in Myopia and Hyperopia: A Systematic Review. Vision (Basel). 2023 Feb 27;7(1):15. doi: 10.3390/vision7010015.
14. Gupta SK, Chakraborty R, VerkicharlaPK. Electroretinogram responses in myopia: a review. Doc Ophthalmol. 2021 Nov 17;145(2):77–95. doi: 10.1007/s10633-021-09857-5.
15. Sun J, Zhou J, Zhao P, et al. High prevalence of myopia and high myopia in 5060 Chinese university students in Shanghai. Invest. Ophthalmol. Vis. Sci. 2012; 53: 7504–7509.
16. Purves D, Augustine GJ, Fitzpatrick D et al. Vision: the eye. In: Purves D, Augustine GJ, Fitzpatrick D et al (eds) Neuroscience, 3rd edn. Sinauer Associates Inc, Sunderland, Massachusetts (USA), 2004. pp 229-257.
17. Quinn N, Csincsik L, Flynn E et al. The clinical relevance of visualising the peripheral retina. Prog Retin Eye Res. 2019; 68:83-109.
18. Robson AG, Nilsson J, Li S et al. ISCEV guide to visual electrodiagnostic procedures. Doc Ophthalmol 2018; 136:1-26.
19. McCulloch DL, Marmor MF, Brigell MG et al. ISCEV Standard for full-field clinical electroretinography (2015 update). Doc Ophthalmol. 2015. 130:1-12.
20. Frishman LJ. Origins of the electroretinogram. In: Heckenlively JR, Arden GB (eds). Principles and practice of clinical electrophysiology of vision, 2nd edn. The MIT Press, Cambridge, MA, 2006. pp 139-183.
21. Perlman I. The Electroretinogram: ERG. In: Kolb H, Fernandez E, Nelson R (eds) Webvision: the organi¬zation of the retina and visual system. University of Utah Health Sciences Center, Salt Lake City (UT), 2020. pp 1371-1412.
22. Robson AG, Frishman LJ, Grigg J, Hamilton R, Jeffrey BG, Kondo M, Li S, McCulloch DL. ISCEV Standard for full-field clinical electroretinography (2022 update). Doc Ophthalmol. 2022 Jun;144(3):165-177. doi: 10.1007/s10633-022-09872-0.
23. Wu De Zheng, Liu Yan. Atlas of testing and clinical application for Roland Electrophysiological Instrument. Beijing-Science and TechnologyPress, 2006. p.5–19.
24. Flitcroft DI, Adams GG, Robson AG et al. Retinal dysfunction and refractive errors: electrophysiological study of children. Br J Ophthalmol. 2005. 89: 484-488].
25. Marmor MF, Fulton AB, Holder GE, Miyake Y, Brigell M, Bach M. ISCEV Standard for full-field clinical electroretinography (2008 update). Doc Ophthalmol (2009) 118:69–77. doi: 10.1007/s10633-008-9155-4.
26. Westall CA, Dhaliwal HS, Panton CM et al. Values of electroretinogram responses according to axial length. Doc Ophthalmol. 2001; 102:115-130. doi: 10.1023/a:1017535207481
27. Koh V, Tan C, Nah G et al. Correlation of structural and electrophysiological changes in the retina of young high myopes. Ophthalmic Physiol Opt. 2014; 34:658-666.
28. Kader MA. Electrophysiological study of myopia. Saudi J Ophthalmol. 2012; 26:91-99.
29. Perlman I, Meyer E, Haim T et al. Retinal function in high refractive error assessed electroretinographically. Br J Ophthalmol. 1984; 68:79-84.
30. Wang P, Xiao X, Huang L et al. Cone-rod dysfunction is a sign of early-onset high myopia. Optom Vis Sci. 2013; 90:1327-1330.
31. Ishikawa M, Miyake Y, Shiroyama N. Focal mac¬ular electroretinogram in high myopia. Nippon Ganka Gakkai Zasshi. 1990; 94:1040-1047.
32. Blach RK, Jay B, Kolb H. Electrical activity of the eye in high myopia. Brit J Ophthalmol. 1966; 50:629-641.
33. Khramenko NI, Umanets MM, Rozanova ZA, Levytska GV. Ocular hemodynamics in patients with rhegmatogenous retinal detachment complicated by choroidal detachment. J of Ophthalmol (Ukraine). 2021; 5: 28-34.

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Abbreviations: *CD, choroidal detachment; ERG, electroretinogram; M, mean value; OPs, oscillatory potentials; RRD, rhegmatogenous retinal detachment; SD, standard deviation*