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Features of vitreoretinal interface in patients with high myopia

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ABSTRACT

In this study we investigated the changes of vitreoretinal interface by spectral optical coherence tomography (SOCT) of the retina in patients with high myopia. One hundred fourteen patients (220 eyes), aged from 43 to 68 years were classified in four groups according to the refraction and presence of posterior vitreous detachment (PVD); A group-high myopia and PVD; B group-high myopia without PVD; C group-emmetropia and PVD; D group-emmetropia without PVD. The patients were performed ultrasound examination on the UltraScan (Alcon) and SOCT on the SOCT Copernicus (Optopol). It was set that the thickness of retina in fovea in high myopia with PVD (219±3.2 μm) was significant more than in emmetropia with PVD (205±4.7 μm) ($p<0.05$). The thickness of retina in fovea in high myopia without PVD (208±2.7) was more than in emmetropia without PVD (193±3.9 μm) also ($p<0.05$). In high myopia with PVD was significantly more frequent distruction of a vitreous, foveoschisis, epiretinal membrane (ERM) and internal limiting membrane (ILM) detachment than in emmetropia with PVD ($p<0.05$). Statistically significant differences in the frequency of macular hole is not revealed in these groups ($p=0.5364$). In high myopia without PVD was significantly more frequent distruction of a vitreous and ERM than in emmetropia without PVD ($p<0.05$). There were no statistically significant differences in the frequency of foveoschisis and ILM detachment ($p=0.2727$). In our opinion, the retinal layers architectonics disorders, increasing thickness of retina and forming of the myopic foveoschisis, PVD in high myopia, there are preconditions for ILM detachment, which leads to gross destructive changes of the vitreoretinal interface.

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1. Introduction

Pathological changes of vitreous and retina in high myopia do not allow to correct this anomaly of refraction adequately, that significantly impairs the quality of life of patients (Bamashmus et al., 2010; Kang et al., 2014). Currently study of the vitreous structure age-related changes is actual, and a specific role is given to the study of the role of the vitreous in the development of retinal complications in increased eye axial length (Johnson, 2010; Itakura et al., 2014).

Changes that occur in the area between two anatomical structures: "Vitreous-retina" can lead to the disturbance of anatomical-topographical relationships in the posterior segment of the eye, up to a posterior vitreous detachment (PVD) (Itakura and Kishi, 2013). It is known that every fifth patient with PVD develops a retinal hole and increased risk of retinal detachment (Coffee et al., 2007) which is especially important for patients with high myopia. But vitreoretinal interface factors have been associated not only for the retinal detachment but for the foveoschisis in myopic eyes (Chebil et al., 2014).

Myopic foveoschisis (MF) predominantly occurs in high myopia with posterior staphyloma, and often induces central vision disorders. In our opinion, the studying of vitreoretinal interface features helps to better understand and detail pathogenesis of MF. Early detection of ultrastructural changes of vitreoretinal interface has an important prognostic value in the diagnosis and complex treatment of patients with high myopia. Based on the above, the purpose of our work is study of the changes of vitreoretinal interface by spectral optical coherence tomography (SOCT) of the retina in patients with high myopia.

Table 1. Descriptive data of groups

	Group A High myopia with PVD	Group B High myopia without PVD	Group C Emmetropia with PVD	Group D Emmetropia without PVD
Number of patients (n, %)	50 (43.9%)	9 (7.9%)	35 (30.7%)	20 (17.5%)
Number of eyes (n, %)	98 (44.5%)	15 (6.8%)	67 (30.5%)	40 (18.2%)
Age (year)	53 (45-61)	52 (43-60)	60 (51-68)	57 (47-62)
Female (n, %)	33 (66.0%)	5 (55.6%)	20 (57.1%)	11 (55.0%)
Male (n, %)	17 (34.0%)	4 (44.4%)	15 (42.9%)	9 (45.0%)
Mean myopic spherical equivalent (D)	-10,4D±0,28 (up -8,0D to -16,0D)	-10.2D±0,42 (up -8,0D to -12.0D)	Em	Em
Axial length (mm)	27.8±0.1 (26.9-30.6)	27.2±0.3 (25.7-28.5)	22.9±0.1 (22.5-24.5)	22.7±0.1 (22.5-23.5)

PVD: Posterior vitreous detachment; **Em:** Emmetropia; **D:** Diopter

2. Materials and methods

One hundred fourteen patients (220 eyes), aged from 43 to 68 years examined at the Department of Ophthalmology of Odessa National Medical University between December 2010 and December 2013 were included in the study. Our study was designed as prospective study. Patients were classified in four groups according to the refraction and presence of PVD. Patients were divided into four groups: High myopia with PVD (Group A), high myopia without PVD (Group B), emmetropia with PVD (Group C) and emmetropia without PVD (Group D).

All the patients in addition to standard ophthalmologic examination were performed ultrasound examination on the device UltraScan (Alcon) and spectral optical coherence tomography of retina on the device SOCT Copernicus (Optopol). Ultrasound examination includes 2 modes: A-scan for eye length measurement and B-scan for PVD and vitreous disturbance evaluation. All patients underwent imaging in standard SOCT mode scanning «Asterisk scanning program» and «3D analysis». It was evaluated retinal thickness in the macula in according to the standard protocol «Macula analysis» and morphological features of macula. Fovea retinal thickness, total PVD, partial PVD, distruction of a vitreous, foveoschisis, epiretinal membrane (ERM), internal limiting membrane (ILM) detachment and macular hole were evaluated in all eyes. All patients were informed about the study, which was approved by the Local Ethics Committee.

Statistical analysis

After coding of the data obtained by the investigation, they were transferred to a computer and analyzed by the Statistica 5.5 packet program. Normality tests were applied for all measurement variables in the statistical analysis. Among the measurement variables, for those with a normal distribution, one-way ANOVA, followed by the Newman-Keuls test was used to compare the groups.

The statistical significance of variety of morphological features of vitreoretinal interface between groups of patients was estimated by Chi-square test. If number of clinical symptom cases in group was 5 or less was used Fisher exact test. Differences in age groups of patients was evaluated by the criterion Kruskal-Wallis. The statistical significance level was set as $p<0.05$ for all the tests.

3. Results

In the present studies it was established the presence of morphometric and morphological differences in the imaging of the macula in the studied groups.

Descriptive data of clinical groups were given in Table 1. There were no differences between all groups in age ($p>0.05$). There were no differences between A and B groups, and between C and D groups in refraction and axial length ($p>0.05$).

Morphometric changes of retina consist in the difference in retinal thickness [(internal limiting membrane (ILM)-retinal pigment epithelium (RPE)] in fovea (Table 2). Thus, retinal

Table 2. Morphometric and morphological changes of vitreoretinal interface (n=number of eyes)

	Group A High myopia with PVD (n=98)	Group B High myopia without PVD (n=15)	Group C Emmetropia with PVD (n=67)	Group D Emmetropia without PVD (n=40)
Fovea retinal thickness (μm)	219±3.2 p1=0.0240 p^3=0.0386	208±2.7 p^2=0.0145	205±4.7 p^4=0.0583	193±3.9
Total PVD	55 (56.1%)	0	48 (71.6%) p^1=0.0432	0
Partial PVD	43 (43.9%)	0	19 (28.4%) p^1=0.0432	0
Distraction of vitreous	33 (33.7%)	5 (33.3%)	12 (17.9%) p^1=0.0256	2 (5.0%) p^2=0.0126
Foveoschisis	10 (10,2%) p^3=0.5541	1 (6.7%)	1 (1.5%) p^1=0,0239	0 p^2=0.2727
ERM	21 (21.4%) p^3=0.6021	3 (20.0%)	1 (1.5%) p^1=0.0001	0 p^2=0.0173
ILM detachment	14 (14.3%) p^3=0.3713	1 (6.7%)	0 p^1=0.0005	0 p^2=0.2727
Macular hole	2 (2.0%) p^3=0.7511	0	2 (3.0%) p^1=0.5364	0

PVD: Posterior vitreous detachment; **ERM:** Epiretinal membrane; **ILM:** internal limiting membrane; p^1-compare the A and C groups, p^2-compare the B and D groups, p^3-compare the A and B groups, p^4-compare the C and D groups.

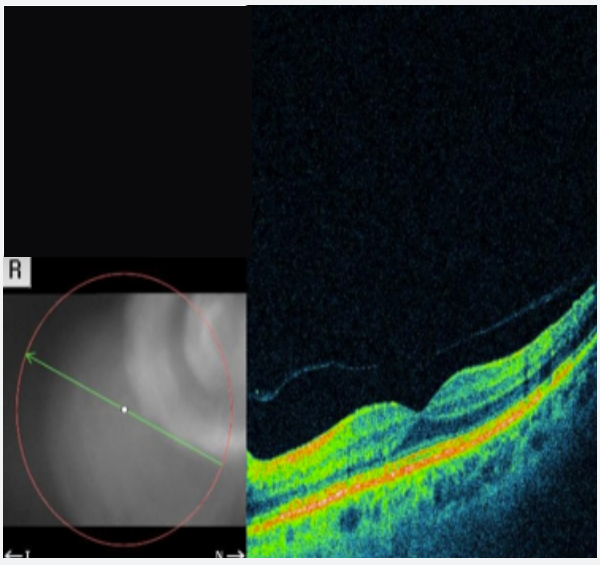

Fig. 1. Total posterior hyaloid membrane detachment. No changes in macular relief, all layers of the retina are differentiated.

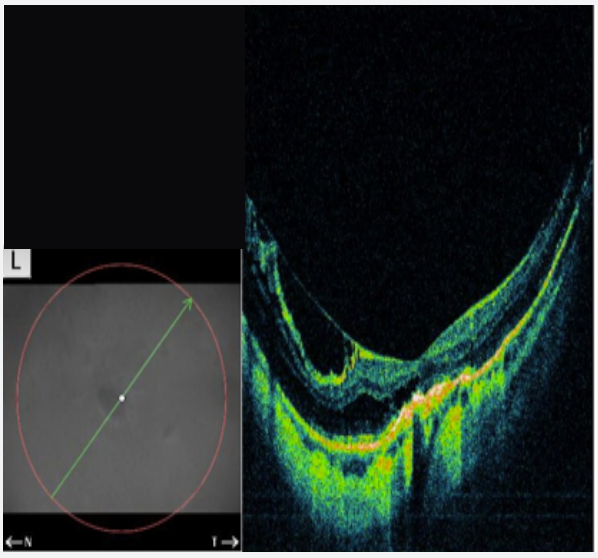

Fig. 3. Tractional myopic maculopathy. Myopic profile due to posterior myopic staphyloma, RPE atrophy, foveoschisis, epiretinal membrane.

thickness in emmetropia without PVD is in the normal range for this age category according to normative data for the used tomography. There is a tendency to increase the thickness of the retina at the fovea in emmetropia with PVD, mainly due to cases with the traction maculopathy. But retinal thickness also is in the normal range ($p>0.05$). In all patients with high myopia, with or without PVD, retinal thickness is more than 200 μm. The thickness of retina in fovea is significant more in high myopia with PVD than in emmetropia with PVD ($p<0.05$). The thickness of retina in fovea in high myopia without PVD is more than in emmetropia without PVD also ($p<0.05$). The retinal thickness in fovea is significant more in high myopia with PVD than in high myopia without PVD ($p<0.05$). Retinal thickness in fovea of all groups and statistical results were shown in Table 2.

Morphological differences of vitreoretinal interface in patients with emmetropia and myopia were the most demonstrative. Data of morphological analysis of SOCT were given in Table 2. Found that total posterior hyaloid membrane detachment was significantly more often in emmetropia in comparing with high myopia. Known that the total posterior hyaloid membrane detachment is more favorable than partial. Perhaps this fact is connected with the fact that at high myopia were identified more expressed changes of vitreoretinal interface. Thus, in high myopia with PVD was significantly more frequent distruction of a vitreous, foveoschisis, epiretinal membrane (ERM) and ILM detachment than in emmetropia with PVD. Therefore identified more expressed changes of vitreoretinal interface. Statistically significant differences in the frequency of macular hole is not revealed in these groups. In high myopia without PVD was significantly more frequent distruction of a vitreous ($p=0.0126$) and ERM ($p=0.0173$) than in emmetropia without PVD. There were no statistically significant differences in the frequency of foveoschisis and ILM detachment. In turn, no significant differences were

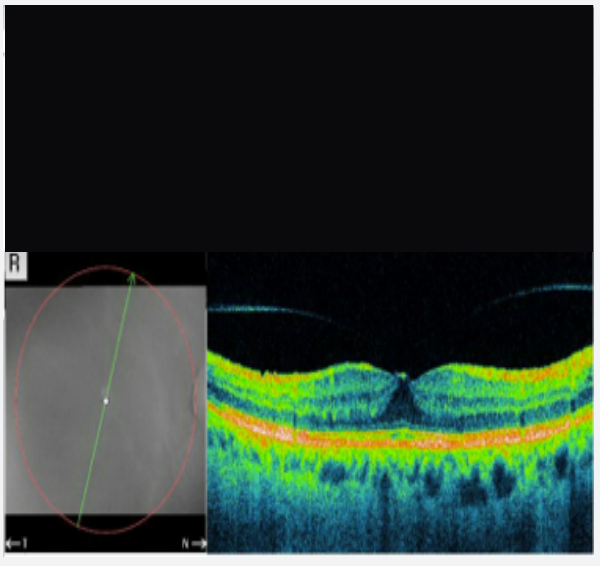

Fig. 2. Partial posterior hyaloid membrane detachment. Macular relief is changed. Thickness of retina in foveola increased.

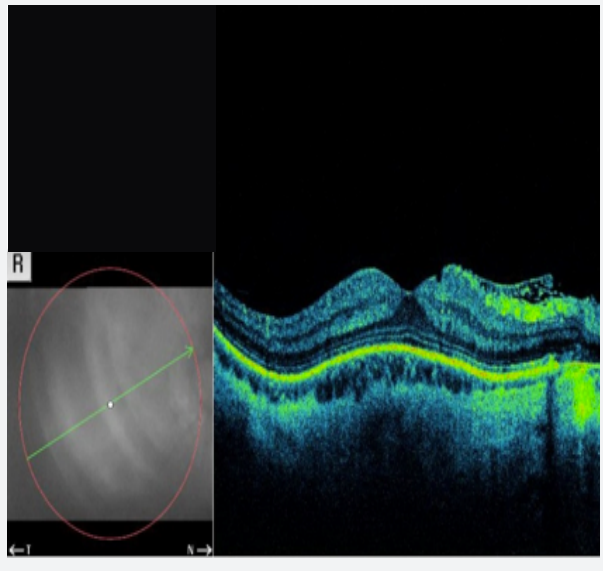

Fig. 4. ILM detachment. Inner retinal layers of the retina are not differentiated.

found during comparing the incidence of foveoschisis, ERM, ILM detachment and macular hole in myopia with and without PVD. Statistical *p* values are shown in Table 2.

In emmetropia without vitreous detachment according to the results of ultrasound scanning, on optical coherence tomography outline of retina is clearly visible, layers are well differentiated, anechogenic area, corresponding to homogeneous vitreous, is over the ILM. In the group of patients with emmetropia with PVD diagnosed by ultrasound scanning, on optical coherence tomography detachment of the posterior hyaloid membrane looked as presence of a linear formation of high density, corresponding to the contour of vitreous cortex, located proximally to the contour of the retina, with the presence or absence of local opacities in the vitreous (Fig. 1).

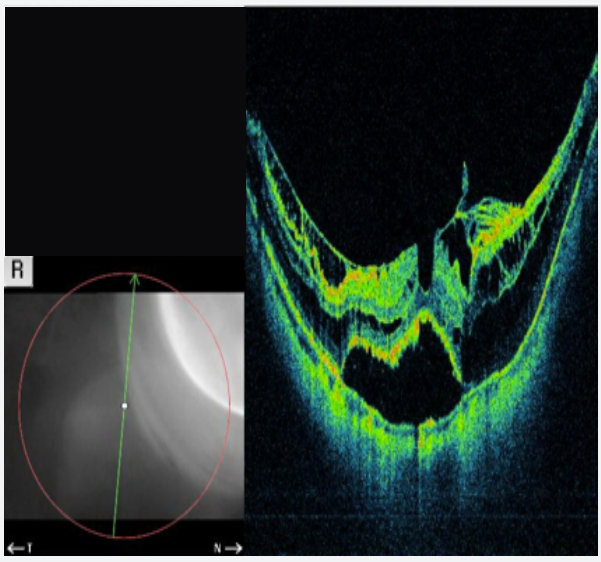

Fig. 5. Tractional myopic maculopathy. Myopic profile due to post opic staphyloma, RPE detachment, foveoschisis, epiretinal membrane, ILM detachment.

In case of partial detachment of the posterior hyaloid membrane, fixing in the area of optic disc or in foveola was observed (Fig. 2). It should be noted that in case of the posterior hyaloid membrane total detachment all layers of the retina were also well differentiated. In high myopia with PVD there was a presence of vitreoretinal tractions and myopic foveoschisis (Fig. 3).

The presence of epiretinal membranes and detachment of ILM in patients with high myopia (Fig. 4, 5) were referred to the most significant changes of the vitreoretinal interface in this monitoring group.

4. Discussion

In our opinion, revealed as a result of our research an increase of retinal thickness in the central parts in high myopia requires a detailed study of the mechanism of development of this process. In the literature, an increase of retinal thickness in partial posterior vitreous detachment due to the development of traction maculopathy is described, but there is some thickening of the retina due to the diffuse edema even in the absence of vitreoretinal tractions (Balashova et al., 2002). Song et al. (2014) also showed that with an increase in myopia degree/length, the average fovea thickness increased and the inner/outer macular thickness decreased. In our opinion, in high myopia the mechanism of increasing of retinal thickness in macula is somewhat different from in emmetropic eye. It is primarily associated with the increasing of eye length, the presence of posterior myopic staphylomas and changed configuration of posterior pole of the eye, the development of myopic foveoschisis that changes not only the architecture of the layers, but also affects the thickness of the retina. PVD aggravates these morphological retinal disorders in high myopia, in which the support function of the vitreous body is impaired, which increases the risk of edema, and in the case of tractions, leads to the formation of pseudo cysts and pre-ruptures (Konidaris et al., 2009).

We established the presence of ERM in myopic maculopathy on the background of high myopia, that is conformed with the literature, but there are no studies demonstrating the specificity of this type of proliferative process for high myopia.

In patients with high myopia, detachment of the ILM is revealed with significantly greater frequency. This type of pathology was described by Panozzo and Mercanti in 2004 and named traction myopic maculopathy. The authors note that in 67% of patients with detachment of internal limiting membrane myopic foveoschisis was detected, which increases the risk of development of the macular ruptures. The presence of thin, opposed to the epiretinal membranes, hyperechogenic membranes on the inner surface of the retina is characteristic for the ILM detachment at optical coherence tomography. The degree of adhesion may also be different, but in places with more expressed detachment typical vertical "columns" with enhanced echogenicity are noticed, extending from the layer of nerve fiber to delaminated internal limiting membrane. The retina in this area loses the normal differentiation of the layers, and the edema progresses as a result of the traction (Faghihi et al., 2010). In our opinion, ILM detachment in myopic maculopathy causes grosser destructive changes of the vitreoretinal interface with damage of the inner retinal layers whereas delaminated inner layer can cause a cascading disruption of the architectonics of underlying retinal layers.

In the detached ILM, collagen fibers and fragments of astroglial cells are found, which, according to the author, is a consequence of the separaton of ILM (Bando et al., 2005). The presence of damaged fibers and cells starts regeneration mechanisms of damage that leads to an increase of the formation of collagen. It is known that longed continuing effect of factors of tissue distruction disrupts the relationship between injury and regeneration, which leads to the disruption of adaptation. In such conditions fibroplastic process, which is an integral part of the reparative regeneration, leads to inadequate fibrogenesis. This subsequently leads to the ILM detachment. However, the trigger mechanisms of forming of such detachment remain unclear (Faghihi et al., 2010).

The presented results of studies have shown that such changes of vitreoretinal interface as ERM, ILM detachment and foveoschisis occurred more frequently in the myopic eyes with increased axial length, compared with emmetropia. However, these vitreoretinal interface differences do not affect the incidence of macular hole. In our opinion, this is due to the different pathogenesis of idiopathic and myopic macular hole.

On the other hand, there are no differences in the incidence

of ERM, ILM detachment, foveoschisis and macular hole in myopia with and without PVD (Table 2). This suggests that increased axial length is more significant factor in vitreoretinal interface and retina architectonics disorders than PVD presence. However, PVD is certainly an important risk factor, especially partial PVD. Because it creates an incentive to the retina tension, and it can cause or proliferation or macular hole.

In our opinion, the retinal layers architectonics disorders, increasing thickness of retina and forming of the myopic foveoschisis, PVD in high myopia, there are preconditions for ILM detachment, which leads to gross destructive changes of the vitreoretinal interface. Early detection of vitreoretinal interface disorder's symptoms by SOCT can be recommended for prognostification of the development of retinal complications of high myopia.

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