The Abnormal Vitreomacular Adhesion Corresponding Serous Macula Detachment Area As A Possible Ocular Risk Factor In Central Serous Chorioretinopathy

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ABSTRACT

Purpose: To investigate the frequency of abnormal vitreomacular adhesion (VMA) in central serous chorioretinopathy (CSCR) using spectral domain optical coherence tomography (SD-OCT).

Materials and Methods: In this observational retrospective case-study, the OCT scans of 30 patients with acute CSCR (Group 1) and 15 patients with chronic CSCR (Group 2) cases which were diagnosed based on clinical, ophthalmological and OCT findings and which was followed in our hospital and 30 control subjects without retinopathy (Group 3) were retrospectively reviewed. The frequencies of VMA in the groups were evaluated.

Results: 31 eyes of 30 patients had acute CSCR and 20 eyes of 15 patients had chronic CSCR. The control group included 30 normal eyes of 30 healthy control subjects. It was found that the frequency of VMA was 38,7% (12 eyes), 50% (10 eyes), 20% (6 eyes) in Group 1, Group 2 and Group 3, respectively. The difference among the frequency of VMAs in groups was statistically significant ($p<0.05$, $p<0.05$, $p<0.05$, respectively).

Conclusion: This pilot study suggests that there is difference between the frequencies of VMA in the patients with CSCR and control group.

Key Words: Central serous chorioretinopathy, Vitreomacular adhesion, Optical coherence tomography.

INTRODUCTION

Central serous chorio-retinopathy (CSCR) is a common chorioretinal disease which seen in middle-age males characterized by serous macula detachment (SMD) of the neurosensory retina and/or the retinal pigment epithelium (RPE).[1-6] The pathogenesis of CSCR has not been understood. However, it has been considered that the choroidal vascular hyper-permeability or autoregulation failure; and RPE barrier and pumping dysfunction might be played in the main role in the pathogenesis of the disease.[5-8] Spectral domain optical coherence tomography (SD-OCT) is a very useful and a non-invasive imaging modality for the diagnosis and follow-up of CSCR. In recent studies, the descriptive OCT findings in CSCR have been demonstrated in detailed.[9-16] The some risk factors such as psychological stress, type A personality, endogenous hyper-cortisolism like Cushing's syndrome, systemic hypertension, pregnancy, obstructive sleep apnea, Helicobacter pylori infection, the usage of corticosteroid, phosphodiesterase-5 (PDE-5) inhibitor.[5-8] However, currently, there is no enough descriptive and detailed publication in ophthalmic literature regarding ocular risk factors for CSCR. Only, in a recent study showed hyperopia was associated with CSCR, while as myopia was protector from CSCR with univariate analysis but no multivariate analysis.[17] The most common SD-OCT findings detected in the patients with acute CSCR are RPE detachment, RPE bulging, SMD, dipping pattern, elongation of photoreceptor outer segments and intra-retinal or sub-retinal hyper-reflective dots.[2, 13, 18-22] However, to our best knowledge, there is an only one study on the findings of vitreoretinal interface (VRI) in SD-OCT in the patients with CSCR in literature.[23] In that study, Theocharis et al. hypothesized that traction from a posterior pre-cortical vitreous pocket (PPVP) and abnormal posterior vitreous

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detachment (PVD) affect the hydraulic conductivity of the macular region and consequently enhance the leakage of fluid under the retina.[23]

Vitreous humour is a transparent gel-like substance occupying vast majority of the intraocular space. It plays in role ocular ingrowth, intraocular oxygen regulation, the protection of ocular tissues against trauma, supporting the lens capsule, the maintaining of ocular media transparency and tonus, the forming of a barrier to various biochemical substances and cells, and it plays some role in refractive media (with refractive index of 1.33) and accommodation. Vitreous includes the water content of 98-99% and the rest content of the meshwork of collagen fibril with hyaluronic acid. It most firmly attached to optic disc, macula, over macular blood vessels and the vitreous base.[24,25] The clearly evaluation of the relationship between the vitreous and the macula has been difficult with only slit lamp bio microscopy. However, the discovering and commonly usage of OCT has provided the more and detailed knowledge to ophthalmologists about the VRI.[26] Vitreous has some viscoelastic and mechanical properties. It protects eye tissues from high-frequency stresses. The interactions between vitreous and retina may affect the retinal and choroidal vasculature and RPE. It has been demonstrated that vitreo-macular adhesion (VMA) and anomalous posterior vitreous detachment (APVD) might also be contributing to the development of neovascular age-related macular degeneration (AMD), diabetic macular edema (DME), retinal vein occlusion (RVO), diabetic retinopathy (DR), tractional maculopathies such as vitreomacular traction syndrome (VMTS), macular hole (MH) and macular pucker (MP)[27-29]. Additionally, vitreous humour is one of the factors that keeps the normal apposition and attachment of neurosensory retina to RPE.[30] So, VRI disorders may contribute to the development of CSCR which is a disease of RPE or choroidal vasculature.

In this study, we aimed to investigate the frequency of abnormal vitreomacular adhesion in CSCR using SD-OCT.

MATERIAL AND METHODS

This study was designed as an observational retrospective comparative case-control study. In the study, the OCT scans of 30 patients with acute CSCR (Group 1) and 15 patients with chronic CSCR (Group 2) cases which were diagnosed based on clinical, ophthalmological and OCT findings and which was followed in our hospital and 30 control subjects without retinopathy (Group 3) were retrospectively reviewed. The frequencies of VMA in the groups were evaluated. The study was designed according to Helsinki Declaration.

Inclusion criteria

The patients with acute and chronic CSCR and gender-matched the healthy subjects aged 20-50 years were included to the study. Acute CSCR was defined as the accumulation of serous fluid between the photoreceptor outer segments and the RPE and serous macular detachment (SMD) of the neurosensory retina self-resolving within 6 months of symptom onset. Chronic CSCR was defined as the persistence of the sub-retinal fluid for greater than 6 months without improvement**.**

Exclusion criteria

The patients with epi-retinal membrane or vitreo-macular traction documented by OCT, and media opacities, vitreous haemorrhage, uveitis, choroidal neovascularization, diabetic maculopathy/retinopathy, and patients with history of previous intraocular interventions such as vitreoretinal, cataract or glaucoma surgery or intravitreal injection and macular laser photocoagulation, and the patients with lower image quality of OCT were excluded from the study.

OCT scanning and analysis

OCT examinations were performed using spectral OCT (RTVue-100 OCT, Optovue, Inc., Fremont, CA). During OCT examination the maculae were scanned by a single retina specialist (SGK) on six radial sections including the horizontal, vertical, and oblique planes through the center of the fovea. Acquired OCT images were evaluated by the two ophthalmologists (BT and SGK). Following OCT findings were evaluated.[9-16:]

- Retina pigment epithelium detachment (PED) was defined as a dome-shaped elevation of the RPE typically seen overlying a homogeneously hypo-reflective space towards inner retina on RPE-choriocapillaris-Bruch membrane complex.[9-16]
- Serous macula detachment (SMD) was defined as the dome-shaped elevation of the posterior surface of the neurosensory retina over a non-reflective black cavity, with minimal shadowing of the underlying tissues and the presence of normal foveal pit but without shadowing in underlying tissues and destruction in the normal reflection of RPE.[9-16]
- Incomplete or Partial PVD was defined as a visible, partially detached PHM somewhere in the peri-macular region and with the vitreous attached over the macula. Posterior vitreous detachment (PVD) was defined as the dehiscence between the posterior vitreous and ILM.[9-16]
- Focal VMA or vitreo-foveal adhesion (VFA) was defined as peri-foveal vitreous separation with remaining vitreomacular attachment and unperturbed foveal

morphologic features and focal adherence of vitreous over the fovea or as the vitreous being attached within a 3-mm radius of the fovea, with surrounding separation of the cortical vitreous above the neurosensory retina without retinal surface contour or morphologic features.[9-16]

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 11.0 (Chicago, IL, USA). Results were given as the means ± standard deviations. The chi-square test was used to compare categorical variables in the study groups, respectively. A P value less than 0.05 was considered as statistically significant.

RESULTS

The mean ages of the Group 1, Group 2 and Group 3 were 38,63±8,53 years (ranging between 20 and 55 years), 45,53±8,03 years (ranging between 32 and 56) years and 37,35±6,64 years (ranging between 20 and 50 years), respectively. The mean age of Group 1 and Group 3 was not significantly different ($p> 0.05$), while the mean age of Group 2 was significantly higher than Group 1 and Group 3 ($p<0.05$, $p<0.05$, respectively). **(Table 1)**

31 eyes of 30 patients had acute CSCR and 20 eyes of 15 patients had chronic CSCR. The control group included 30 normal eyes of 30 healthy control subjects. It was found that the frequency of VMA was %38,7 (12 eyes), %50 (10 eyes), %20 (6 eyes) in Group 1, Group 2 and Group 3, respectively. The difference among the frequency of VMAs in groups was statistically significant ($p<0.05$, $p<0.05$, $p<0.05$, respectively). **(Table 1)**

CONCLUSION

Vitreous humour provides the good shock-absorbing and the protection to a lot of ocular tissues against mechanical stress, friction, and vibration because its high content of hyaluronic acid acts as a viscoelastic substance. VMA is one of the results of APVD. Although VMA's itself is not dangerous, it can cause vitreomacular traction syndrome (VMTS), and eventually severe retinal damage and visual loss. Additionally, it has been considered that the symptomatic VMA could contribute to the development of macular hole (MH) and macular pucker (MP). VMA may also be associated with neovascular age-related macular degeneration (AMD), diabetic macular edema (DME), retinal vein occlusion (RVO), and diabetic retinopathy (DR).[27-31] According to "Classification of Vitreomacular Adhesion, Traction, and Macular Hole" by

Table 1. *The optical coherence tomographical and demographical data in the study groups.*

	Acute CSCR (n=31 eyes)	Chronic CSCR (n=20 eyes)	Control group (n=30 eyes)
Age (years)	38,63±8,53	45,53±8,03	37,35±6,64
VMA (%)	12 (38,7%)	10 (50%)	6 (20%)

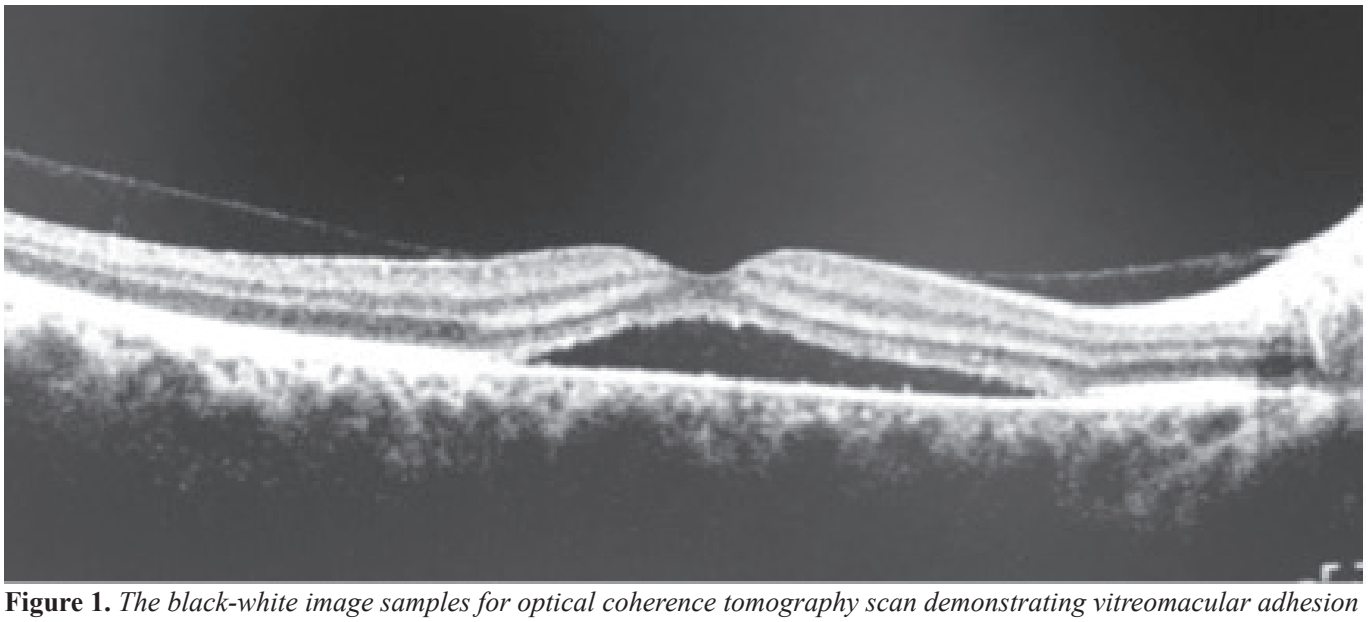

Figure 1. *The black-white image samples for optical coherence tomography scan demonstrating vitreomacular adhesion and focal partial posterior vitreous detachment corresponding serous macular detachment from a case.*

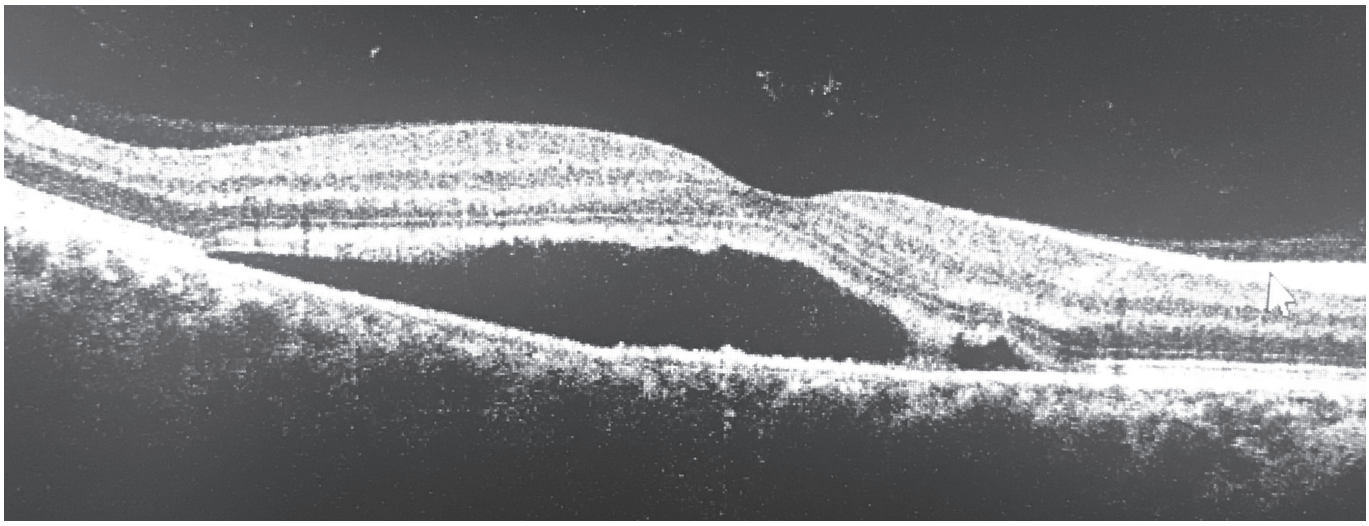

Figure 2. *OCT image of another case with vitreomacular adhesion in the acute CSCR.*

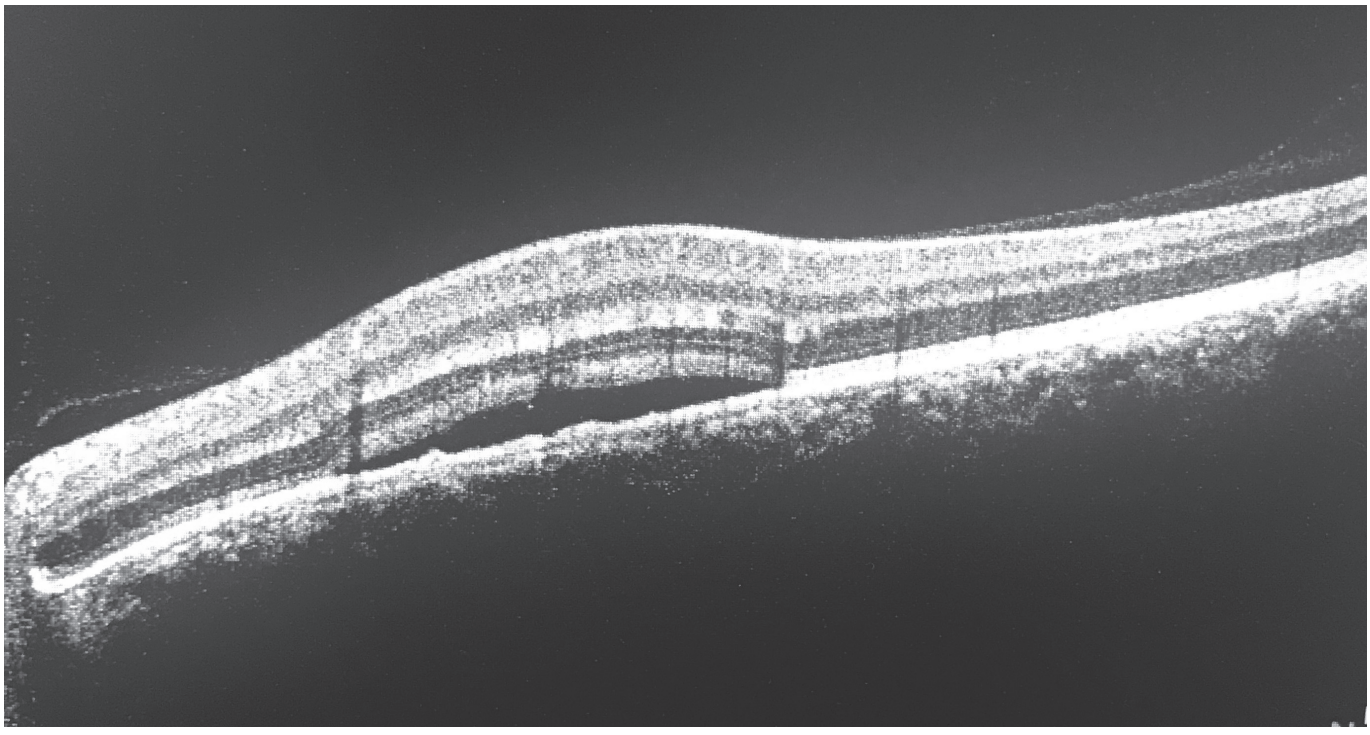

Figure 3. *OCT image of a case with vitreomacular adhesion in the chronic CSCR.*

‘‘The International Vitreomacular Traction Study Group’’, VMA is diagnosed in the presence at least one of those findings in OCT: partial vitreous detachment as indicated by elevation of cortical vitreous above the retinal surface in the peri-foveal area; persistent vitreous attachment to the macula within a 3-mm radius from the center of the fovea; acute angle between posterior hyaloid and inner retinal surface; absence of changes in foveal contour or retinal morphology.[32]

APVD is due to an imbalance between the degree of gel liquefaction and weakening of vitreoretinal adhesion. If the degree of vitreous liquefaction overwhelms the degree of weakening of vitreoretinal adherence, anomalous and strong vitreoretinal traction at this interface may cause VTMS, retinal or intravitreal haemorrhages in especially in ischemic and diabetic retinopathies, DME, posterior vitreo-schisis (PVS), myopic retino-schisis (MRS), MP, MH, periphery retinal tears/detachments, vitreo-papillary traction syndrome (VPTS), neovascular AMD. Additionally, it can aggravate the neovascularization in disk (NVD) and elsewhere retina (NVE) in especially in proliferative vitreoretinopathy (PDVR) and retinal vein occlusion (RVO).[24,27-32]

To screening the current ophthalmologic literature, there

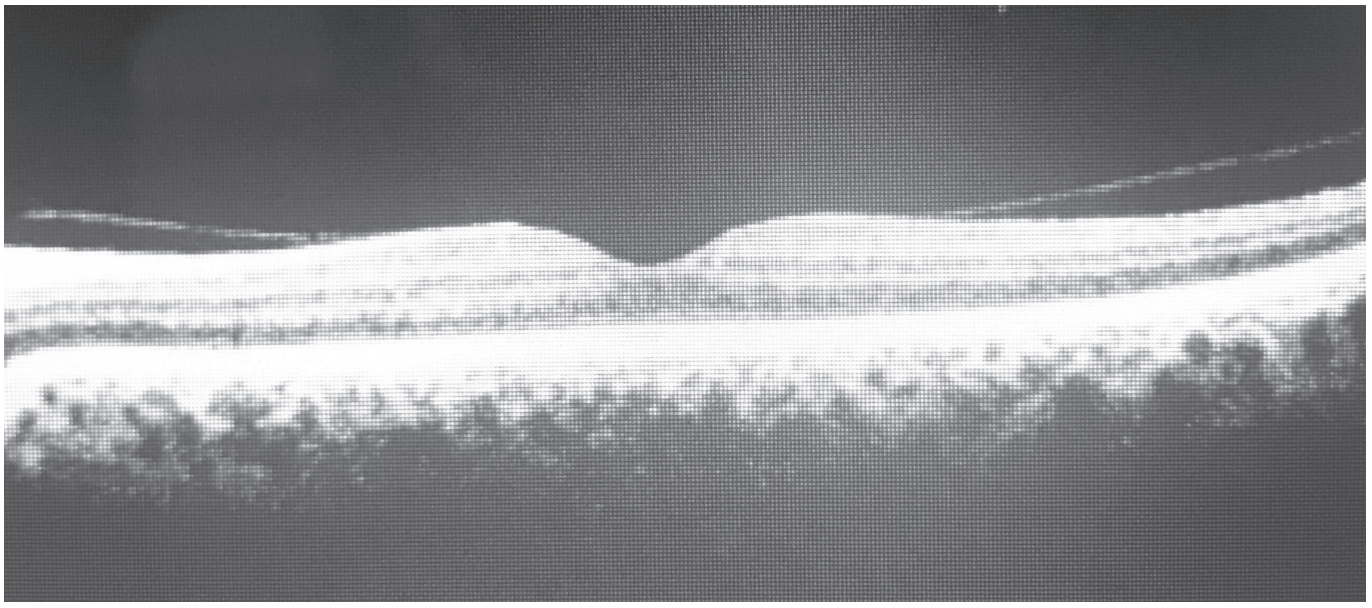

Figure 4. *OCT image of a case with vitreomacular adhesion in the control group.*

is an only one study on the findings of VRI in SD-OCT in the patients with CSCR.[23] In that study, Theocharis et al. reported that VRI has different characteristics in CSCR cases (especially in acute cases) than in normal population with the partial-PPV and that the changes in VRI are bilateral and occur earlier in the patients with CSCR than normal healthy subjects.

Furthermore, it appears that the most intense velocities of vitreous are generated close to the lens and in the posterior part of the eye globe**.** It has also been shown that the real shape of the vitreous chamber may induce boundary layer separation and that dynamic tractional force on the vitreous caused by physiological eye movements cause vitreous separation.[33] At present, the most widely accepted theory concerning the pathophysiology of CSC is that increased choroidal permeability and elevated hydrostatic pressure may lead to serous detachment of the RPE; a mechanical disruption of the RPE may cause the characteristic focal fluorescein leakage, whereas the chronic pressure may induce RPE atrophy.[34,35] As far as we know, all studies of CSC have been focused on the mechanical phenomena that take place under the retina such as hydrostatic pressure and RPE microrip. Only recently a study focused at the level of the retina and they found that CSC reduces the retinal vein flow using noninvasive retinal function imaging (RFI).[36] Our study is the first study that examines the vitreoretinal interface and the patterns of vitreous adherence over the macula, which could theoretically influence the equilibrium of forces applied to the posterior pole in patients with CSC.

The lacuna pattern consists of an optically empty cavity in front of the macula with the PHM attached over at least the posterior pole and represents the age-related or disease-induced liquefaction of the vitreous or the vitreoschisis resulting from an anomalous PVD.[37,38] The partial-PVD pattern shows a partially detached PHM and represents a stage of a normal PVD process or an anomalous PVD, with or without a coexisting lacuna pattern. The VMA pattern is a form of partial PVD that is more focal, and it is more likely to become pathological. When a distinct posterior hyaloid membrane (PHM) or a lacuna is not seen in SD-OCT images, the vitreous attachment status cannot be clarified, because extensive liquefaction of an attached vitreous or extensive contraction of a detached vitreous may be misdiagnosed as a totally detached vitreous or as an attached vitreous, respectively. The lacunae, the partial-PPV and the VMA patterns together are proof of limited vitreous attachment over the posterior pole. Based on these data, we presumed that the lacunae, the partial-PVD and the VMA could be associated with the consequences of anomalous PVD and / or the traction during ocular movements.

Biomechanical studies show that the shear force from vitreous movements increases as the thickness of the eye wall decreases.[39] Thus, the vitreoretinal interface may detach because of increased shear stress in areas adjacent to the thick choroid. This could explain the attachment of vitreous preferentially at the roof of any retina elevation.[36.] All these assumptions could explain the increased prevalence of abnormal vitreomacular adhesion in both eyes of CSCR patients.

The most important age-related change in the human vitreous gel is posterior vitreous detachment (PVD). Defined as a separation between the posterior vitreous cortex and the internal limiting membrane (ILM) of the

retina, PVD represents the culmination of the aging and liquefaction of human vitreous and may induce several potentially serious pathologic events at the vitreoretinal interface. It is commonly believed that age-related PVD occurs as an acute event, precipitated by the abrupt development of a dehiscence in the thin posterior cortical vitreous layer overlying the macular region. This is thought to result in the sudden passage of synchetic or liquefied vitreous into the subhyaloid space, causing a rapid and smooth separation of the vitreous cortex from the retina, beginning posteriorly and progressing peripherally to the vitreous base region. Partial PVDs are thought generally to progress rapidly to complete PVD.[24-41]

According to current literature, the apposition or adherence of the posterior vitreous has been classified into five stages:[42]

- Stage 0: No evidence of PVD
- Stage 1: Perifoveal PVD with vitreo-foveal adhesion
- Stage 1+ PVD: Perifoveal PVD extending throughout the entire periphery, with vitreous adhesions only at the macula and optic disc.
- Stage 2: Perifoveal vitreous detachment with no vitreo-foveal adhesion
- Stage 3: Complete PVD except for vitreo-papillary adhesion
- Stage 4: Complete PVD

In conclusion, abnormal VMA may contribute to the development of CSCR. So, the careful and detailed evaluation of VRI using by OCT should be considered. Further studies with large patient numbers will be able to present more knowledge for the explanation of the pathogenesis of CSCR.

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