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Vitreoretinal interface changes after uncomplicated phacoemulsification

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SUMMARY
Introduction/Objective The aim of this work was to examine the incidence of posterior vitreous detachment (PVD) after uncomplicated phacoemulsification, as well as the importance of optical coherence tomography (OCT) in detecting early changes on vitreoretinal interface.
Methods PVD was evaluated in 120 eyes of 120 patients aged between 50 and 70 years by the combination of OCT and ultrasonography immediately prior and one, six, and 12 month after the phacoemulsification cataract surgery with intraocular lens implantation.
Results The mean age was 57 ± 8.8 years in female and 58.6 ± 8.8 years in male subjects. The progress statuses were compared after cataract surgery at three time-points: after one, six, and 12 months. Significant progression of PVD in time was confirmed ($\chi^2 = 78.32$, $p < 0.001$). The Wilcoxon test determined that after six months ($p < 0.001$) and 12 months ($p < 0.001$) the disease progression was statistically significant in comparison to measurements after one month. In addition, after 12 months, in relation to progression status established after six months, there was significant progression of the disease ($p < 0.001$).
Conclusion Vitreous body detachment after phacoemulsification surgery is common, and OCT plays a very important role in detecting initial changes on the vitreoretinal interface.
Keywords: posterior vitreous detachment; phacoemulsification; optical coherence tomography

INTRODUCTION

The vitreous body is the clear gel that comprises more than three quarters of the eye. It is a reservoir for lens nutrients. Human vitreous body is composed mainly of water (99%), meshwork of collagen fibrils with proteoglycans and glycosaminoglycans, among which hyaluronic acid is the most important for metabolism. These components at such a concentration form a gel-like structure of the vitreous body, maintain viscosity, and provide transparency necessary for achieving maximum visual acuity [1]. Mid-20th century, the role of the vitreous body was minimally recognized, but it is well known nowadays that in the vitreous body, as well as in many other human tissues, intensive chemical processes occur and cause the changes of its structure. Its structure is just seemingly simple, but the tissue of the same structure has not been synthetized yet.

Hydrated molecules of hyaluronic acid are the primary location for accumulation of bonded water in the vitreous body. Bonded water is converted into free water by the aging process, resulting in reduced viscosity of hyaluronic acid, followed by reduced viscosity of the vitreous body. It is believed that the process of liquefaction is more pronounced in individuals with nuclear cataract.

The outermost layer of the vitreous body is called the posterior vitreous cortex (PVC) and completely adheres to the internal limiting membrane (ILM) of the retina. Posterior vitreous detachment (PVD) is defined as the detachment of the PVC from the inner limiting membrane of the retina and it is one of the most characteristic signs of the aging process of the eye [2]. PVD is a slow progressive process induced by liquefaction of the vitreous gel in front of the macula [3]. It begins in the perifoveal macula, with the PVC separation from the retinal ILM, thus forming lacunae spaces that coalesce and enlarge. Then, *aqueous vitreous* through hyaloid, Cloquet's canal causes hydrodissection of the PVC from the ILM and forms retrohyaloid space [4].

At this phase, the vitreous cortex is still attached in the foveal region and is defined as foveal adhesion. Foveal adhesion has clinical relevance for the conditions such as vitreomacular traction, diabetic macular edema, macular holes, and exudative age-related macular degeneration, since they have an impact on visual acuity and direct correlation with the pathogenesis of the pathological process in the posterior pole of the eye [5].

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In youth, collagen fibers are firmly attached to the ILM by macromolecules such as laminin, fibronectin, and chondroitin, thus enabling a tight connection between the vitreous body and the retina.

Besides increasing age, PVD may result from myopia, infections and inflammations, intraocular drug application, laser treatment, eye trauma, as well as cataract surgery [6].

B-scan ultrasonography has long been considered a superior method for defining PVD, especially in patients with blurred optical media. In patients whose vitreous cortex is less than 2 mm away from the retina, the resolution of standard devices of this kind does not grant the visualization of the process and may be unrecognized at early stages. Today, the introduction of optical coherence tomography (OCT) method not only enables more precisely the diagnosis of PVD, but it also detects early, previously unrecognized vitreous body detachment, and determines the stages of the process occurring at the PVC–ILM interface as well [7, 8].

There are FIVE distinct stages of PVD [9]: stage 0 – characterized by no PVD; stage 1 – focal perifoveal PVD involving 1–3 quadrants over the fovea; stage 2 – perifoveal PVD in all four quadrants over the fovea; stage 3 – complete detachment of the PVC from the fovea, with persistent attachment to the optic nerve head and midperipheral retina; and stage 4 – vitreous is completely detached from the fovea, as well as from the optic nerve head and fundus midperiphery.

The aim of this study was to examine the incidence of PVD after uncomplicated phacoemulsification, as well as the importance of OCT in detecting early changes on the vitreoretinal interface.

METHODS

All participants underwent complete ophthalmological examination from June 2014 to June 2016 at the Clinic Maja Ophthalmology Eye Hospital, Niš, Serbia. This study was approved by the institutional Ethics Committee, following the tenets of the Declaration of Helsinki, with informed consent obtained from all the participants. The study comprised 120 eyes of 120 patients aged 50–70 years. Before the operation, all the patients signed the written informed consent on using their parametric values in the study and on potential intraoperative complications.

Preoperatively, all the patients underwent the same, routine procedure involving determination of the best corrected visual acuity, measurement of intraocular pressure by applanation tonometry, examination of anterior and posterior eye segment using biomicroscopy with indirect ophthalmoscopy. All the patients also underwent high resolution OCT (Cirrus; Carl Zeiss Meditec, Jena, Germany) and ultrasound by using a 10-MHz probe (SONOMED E-Z; SonomedEscalon, New Hyde Park, NY, USA).

Inclusion criteria were the presence of age-related cataract in patients over 50 years of age, visual acuity greater than 0.1, axial length of the eye from 22 mm to 25 mm, the absence of PVD or the presence of the initial stage of PVD.

The patients excluded from the study had already present a) macular pathologies, such as epiretinal membrane, macular holes, or age-related macular degeneration; b) vascular occlusion of retinal blood vessels or retinal dystrophy; c) confirmed presence of glaucoma or uveitis; d) amblyopic eyes; e) previous intraocular surgeries or laser interventions; f) local or systemic therapy with corticosteroids or diuretics that can affect vitreoretinal surface and macular thickness; g) diabetes and other systemic diseases that affect vision; h) patients in whom the quality of the OCT scan was inadequate for interpretation; i) intraoperative complications; and j) incomplete follow-up.

On the ultrasound, detached posterior cortex is presented as low reflective membrane that floats into vitreous cavity. When interpreting OCT scan findings, discrete linear signal adjacent to inner retina is defined as detachment of the PVC.

All the patients were operated on by the same, experienced surgeon. Ultrasonography and OCT examinations were performed by another surgeon in order to obtain objective findings.

One day prior to surgery, ofloxacin drops (Uniflox, Unimed Pharma, Belgrade, Serbia) were administered to all the patients. The surgery was performed under topical anesthesia using tetracaine 0.5% (tetracaine hydrochloride 0.5% drops, Bausch + Lomb, Rochester, NY, USA) after the patients received tropicamide 1% drops (Mydriacyl 1%, Alcon, Fort Worth, TX, USA) every 10 minutes for four times. The surgical method was stop-and-chop phacoemulsification with the OZIL probe on Infiniti Vision System apparatus (Alcon), along with flexible lens implantation into the capsular bag. Patients with any intraoperative complications, such as posterior capsule rupture, vitreous loss, or prolapse were not included in the results of the study. The patients were scheduled for check-ups at days 1 and 7 after the intervention, then at one, six, and 12 months.

Biomicroscopy, OCT, and ultrasonography were performed immediately prior the intervention, then according to the protocol at one, six, and 12 months after the intervention.

Statistical analysis

Statistical data processing was performed in IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Primarily obtained results were analyzed using descriptive statistics methods and hypothesis tests method. Descriptive statistical methods used included measures of central tendency, measures of variability and structure indicators expressed in percentage. For determination of normal distribution, coefficient of variation CV, values of scunis ("skewness") and kurtosis ("peakedness/flatness"), the Kolmogorov–Smirnov and the Shapiro–Wilk test were used. The Wilcoxon rank test was used to analyze the differences in the disease status at two time-points. The Friedman test compared PVD progression status after cataract surgery at three time-points.

RESULTS

The study included 120 patients, 45 of whom were females and 75 were males. The mean age was 59 ± 8.8 years (the mean age in females was 57 ± 8.8 years and in males it was 58.6 ± 8.8 years).

Prior to surgery, the patients were initially measured for the best corrected visual acuity and axial length – the data is presented in Table 1.

Table 1. Central tendency measures

Variables	mean ± sd	med. (min.–max.)
BCVA	0.4 ± 0.2	0.4 (0.1–0.7)
Lax	23.6 ± 1.0	23.5 (22.0–25.6)

BCVA – best corrected visual acuity; Lax – axial length

Initially, 66 (55%) patients had one of the PVD stages, as follows: 40 patients (60.6%) with stage 1; 16 patients (24.2%) with stage 2; 10 patients (15.2%) with stage 3; and PVD was not registered in 54 patients (45%).

After one month, the disease progression was registered in 48 patients (40%), out of whom complete PVD was determined in six patients (three patients with initial stage 1, two patients with initial stage 2, and 1 patient with initial stage 3). In 72 patients (60%), the condition remained unchanged. After six months, complete PVD was reported in seven new patients, so there was a total of 13 patients with complete PVD after six months (in two new patients with initial stage 2, in two patients with initial stage 3, and in three patients with previously absent complete PVD that is present now). The disease progression was registered in 76 patients (66.7%), and there were no changes in 38 patients (33.3%) (114 of them now without complete PVD). After 12 months, complete PVD was established in 15 more patients (in four new patients with initial stage 1, in two new patients with initial stage 2, and in 11 patients with complete PVD which was not present previously), which makes a total of 28 patients with complete PVD. The disease progression was seen in a total of 93 patients (86.9%), and in 14 (13.1%) the condition remained unchanged (out of them, 107 are now without complete PVD) (Table 2).

By using the Friedman test of repeated measures, the progress statuses were compared after the cataract surgery at three time-points – after one, six, and 12 months. Significant progression of PVD in time was confirmed (χ^2 = 78.32, df = 2, p < 0.001). The Wilcoxon test determined that after six (p < 0.001) and 12 months (p < 0.001) the disease progression was statistically significant in comparison to measurements after one month. In addition, after 12 months, in relation to progression status established after six months, there was significant progression of the disease (p < 0.001).

DISCUSSION

PVD is very common in patients who underwent cataract surgery with phacoemulsification. There are many reasons for it, but the main ones are the potentials of greater fluctuation of the vitreous body and greater anteroposterior traction enabled by lesser thickness of intraocular lens in comparison to natural lens [10]. Increased vitreous gel liquefaction caused by ultrasonography effects, as well as fluid flow through the zonulae due to the surgery, are also the reasons for higher incidence of PVD after phacoemulsification surgery [11, 12].

Other authors obtained the results similar to ours. Ivastinović et al. [13] reported that PVD developed in 71.9% of patients three months postoperatively. Higher incidence of PVD in their findings in comparison to our study is explained by the age of their patients, who were older on average than the group of patients we followed. Ivastinović et al. [14] reported in the appendix to their study that 100% of patients developed some stage of PVD one year postoperatively. Unlike the authors of this study, Mirshahi et al. [15] also monitored PVD development by ultrasonography exclusively and reported that 58.6% of patients developed some PVD stage after one year.

It can be seen that OCT allows the detection of early stages of PVD. OCT identifies more cases of PVD than other available methods. To the best of our knowledge, early stages of PVD would have been unrecognized without the use of OCT [13].

Complications associated with PVD were not common in our study, symptomatic PVD was registered in four patient out of 120 (3.33%), which correlates with the literature data [16].

We believe that the inclusion of a greater number of patients would provide a better insight into potential risk factors, sex differences and age impact, but limitations in finding more patients to be included in a study are preoperative media transparency, as well as preoperative nonexistence of PVD in a relatively older population.

CONCLUSION

Vitreous body detachment after phacoemulsification surgery is common, and OCT plays a very important role in detecting initial changes on the vitreoretinal interface.

Table 2. Illustration of PVD progression at one, six, and 12 months after cataract surgery

Initial PVD stage before the surgery		Progression after			No progression after			Complete PVD		
		1 month	6 months	12 months	1 month	6 months	12 months	1 month	6 months	12 months
No PVD	54	17	34	44	37	20	7	0	3	14
Stage 1	40	19	23	33	21	14	4	3	3	7
Stage 2	16	8	10	9	8	4	3	2	4	6
Stage 3	10	4	9	7	6	0	0	1	3	3
Total		48	76	93	72	38	14	6	13	28

PVD – posterior vitreous detachment

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Промене на нивоу витреоретиналне додирне површине после некомпликоване факоемулзификације

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САЖЕТАК
Увод/Циљ Циљ рада је био испитати учесталост задње аблације стакластог тела (ЗАСТ) после некомпликоване операције катаракте методом факоемулзификације, као и важност оптичке кохерентне томографије (ОКТ) у детекцији раних промена на витреоретиналној површини.
Методе ЗАСТ је евалуирана код 120 очију од 120 болесника комбинацијом ОКТ и ултрасонографије непосредно и после једног месеца, после шест и после 12 месеци од операције катаракте методом факоемулзификације са имплантацијом интраокуларних сочива.
Резултати Средња старост је била 57 ± 8,8 код женских и 58,6 ± 8,8 година код мушких испитаника. Стање прогресије је поређено после операције катаракте у три периода: после једног месеца, после шест и 12 месеци. Уочена је висока статистичка значајност у напредовању ЗАСТ током времена ($\chi^2 = 78,32$, $p < 0,001$). Вилкоксонов тест је показао високо статистички значајне разлике у детектованим променама после шест месеци ($p < 0,001$) и после 12 месеци ($p < 0,001$) у односу на налаз после једног месеца. Такође и после 12 месеци у односу на налаз после шест месеци ($p < 0,001$).
Закључак ЗАСТ после операције катаракте методом факоемулзификације честа је појава и ОКТ има важну улогу у откривању иницијалних промена на нивоу витреоретиналне површине.

Кључне речи: задња аблација стакластог тела; факоемулзификација; оптичка кохерентна томографија