Incidence of posterior vitreous detachment after cataract surgery

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PURPOSE: To report the incidence of posterior vitreous detachment (PVD) after uneventful state-of-the-art small-incision phacoemulsification with implantation of a posterior chamber intraocular lens (PC IOL).

SETTING: Department of Ophthalmology, Ludwigshafen Hospital, Ludwigshafen, Germany.

METHODS: This prospective study evaluated the vitreous status of eyes by biomicroscopic examination, indirect binocular ophthalmoscopy, and B-scan ultrasonography before planned cataract surgery. Patients with the posterior vitreous attached were included for follow-up and examined 1 week, 1 month, and 1 year after uneventful phacoemulsification with PC IOL implantation. The preoperative prevalence and postoperative incidence of PVD were determined by ultrasonography.

RESULTS: The study included 188 eyes of 188 patients (131 women, 57 men) with a mean age of 77.2 years. The mean spherical equivalent was −0.78 diopter (D) (range −8.75 to +6.25 D) and the mean axial length (AL), 23.22 mm (range 20.50 to 26.04 mm). Preoperatively, 130 eyes (69.1%) had PVD and 58 eyes (30.9%) had no PVD. Postoperatively, 12 eyes (20.7%) developed PVD at 1 week, 18 eyes (31%) at 1 month, and 4 eyes (6.9%) at 1 year. The vitreous body remained attached to the retina in 24 eyes (41.4%) 1 year after surgery. No preoperatively measured parameter (eg, age, refraction, AL, effective phacoemulsification time) was predictive of the occurrence of PVD after cataract surgery.

CONCLUSION: The occurrence of PVD after modern cataract surgery was frequent in cases in which the posterior hyaloid was attached to the retinal surface preoperatively.

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Small-incision phacoemulsification with implantation of a foldable intraocular lens (IOL) in the capsular bag is among the most common and successful surgical procedures in ophthalmology. In general, the surgery has good clinical and functional outcomes and leads to high patient and clinician satisfaction. However, cataract surgery is also a risk factor for rhegmatogenous retinal detachment, both in myopic eyes[1] and emmetropic eyes.[2–8] One of the most important possible changes in the posterior segment after cataract surgery is posterior vitreous detachment (PVD).[5] There are different theories about the onset of PVD after cataract surgery.[8,9] Posterior vitreous detachment is more common in eyes in which the crystalline lens has been removed.[5,6,9–12] Furthermore, there is a need for discussion about what effect PVD might have on pathological developments in the posterior segment of the eye. It has been reported that 10% to 15% of eyes developed retinal tears when PVD was present.[12]

Regarding the rate of PVD after cataract surgery, studies of aphakic eyes and extracapsular cataract extraction (ECCE) with and without IOL implantation should be considered separately from studies of modern phacoemulsification and in-the-bag IOL implantation. In this study, we assessed the incidence of PVD by B-scan ultrasonography and biomicroscopic examination in patients having state-of-the-art small-incision cataract surgery with posterior chamber IOL (PC IOL) implantation.

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Table 1. Preoperative distribution of PVD (partial or complete).

Status	Eyes (%)
No PVD	58 (30.9)
Partial PVD	26 (13.8)
Complete PVD	104 (55.3)
PVD (partial and complete)	130 (69.1)

PVD = posterior vitreous detachment

PATIENTS AND METHODS

Study Population and Preoperative Evaluation

In this prospective noncomparative case series, eyes were examined before cataract surgery. The study was performed at the Department of Ophthalmology, Ludwigshafen Hospital, Germany, and was conducted according to the tenets of the Declaration of Helsinki. Patients gave informed consent after receiving an explanation of the investigative nature and intent of the study.

Preoperatively, the status of the vitreous was evaluated by biomicroscopic examination, indirect binocular ophthalmoscopy, and B-scan ultrasonography. The standard preoperative examination included uncorrected visual acuity, refraction, best spectacle-corrected visual acuity, anterior and posterior segment biomicroscopy, ultrasound biometry, and laser interferometry (IOLMaster, Carl Zeiss Meditec). Only cases without PVD were included in the follow-up study. One week, 1 month, and 1 year after surgery, the following examinations were performed in patients without PVD: best corrected visual acuity, biomicroscopy, indirect binocular ophthalmoscopy, and B-scan ultrasonography, with special attention paid to the development of new PVD.

Patients with a history of uveitis, significant macular pathology, previous eye surgery, or intraoperative complications (eg, capsule rupture, vitreous loss) or those who were unable to attend all follow-ups were excluded from the study.

Surgical Technique

All patients had small-incision phacoemulsification with foldable IOL implantation in the capsular bag by 1 of 3 experienced surgeons (L.O.H., K.W., A.M.). A temporal clear corneal incision and 2 paracenteses were made with a preset diamond step keratome, and the anterior chamber was filled with an ophthalmic viscosurgical device (OVD). Subsequently, continuous curvilinear capsulorhexis (CCC), hydrodissection, and hydrodelineation were performed. The diameter of the CCC was between 4.5 mm and 6.0 mm. Phacoemulsification was performed with the divide-and-conquer and phacofracture techniques. Residual cortex removal and posterior capsule polishing were performed using a bimanual irrigation/aspiration system through the paracentesis. The anterior chamber and capsular bag were inflated with OVD. The size of the initial incision was 2.8 mm. Acrylic PC IOLs were implanted in the capsular bag. The OVD was evacuated and replaced with balanced salt solution (BSS). All incisions were left sutureless. At the end of the procedure, all wounds were checked for leakage and found to be watertight.

Table 2. Onset of PVD after cataract surgery in eyes without preoperative PVD (n = 58).

	Eyes (%)			
Postop Time	Partial PVD	Complete PVD	PVD (Partial and Complete)	No PVD
1 week	8 (13.8)	4 (6.9)	12 (20.7)	46 (79.3)
1 month	13 (22.4)	5 (8.6)	18 (31.0)	40 (69.0)
1 year	3 (5.2)	1 (1.7)	4 (6.9)	24 (41.4)

PVD = posterior vitreous detachment

B-Scan Ultrasonography

Before cataract surgery, B-scan ocular sonography (I^3 System ABD, I^3 Innovative Imaging, Inc.) was performed by the same experienced ocular sonographer (F.H.). Particular attention was paid to the vitreous body and to the prevalence, location, and size of the PVD. The procedure was performed with topical anesthesia using a standard direct contact method and high to maximum gain for the detection and localization of ultrasonographic PVD signs. The examiner looked for signs of a low-reflective mobile membrane or a ring inserted in the vitreous base, which was partially or completely detached from the posterior pole of the eye. Every quadrant and the posterior pole were defined and assessed separately by the sonographer. All images were saved for post-interventional comparison, and the location of the PVD was described. This procedure was repeated in all patients without PVD by the same sonographer 1 week, 1 month, and 1 year postoperatively for detection of vitreoretinal alterations, in particular partial or complete PVD.

Statistical Analysis

All data were collected and evaluated by the same researcher (K.L.) using Microsoft Excel (version 9.0, Microsoft, Inc.). In the evaluation of the B-scan results, the number and percentage of new occurrences of PVD were determined as described above. Additional analyses were performed after the data were subdivided into 3 groups defined by age (<60 years; 61 to 80 years; ≥ 81 years) and by axial length (AL) (<22.01 mm; 22.01 to 24.00 mm; >24.01 mm). The Wilcoxon test was used to detect statistical significance.

RESULTS

The study comprised 188 eyes of 188 patients (131 women, 57 men) with a mean age of 77.2 years (range 39 to 99 years). All cataract surgeries were uneventful.

Table 1 shows the preoperative distribution of PVD. Fifty-eight eyes (30.9%) had no echographic signs of PVD and were followed postoperatively. The remaining 130 patients (69.1%) had partial or complete PVD detected by ultrasound. Of the patients with no preoperative PVD, 32 were men and 26 were women. The mean spherical equivalent (SE) was −0.78 diopters (D) (range −8.75 to +6.25 D). The median effective phacoemulsification time was 0.595 seconds (mean 3.213 ± 6.84 seconds; range 0.001 to 31.31 seconds).

Table 3. Development of PVD (partial and complete) by age group.

			Eyes (%)						
			PVD at 1 Wk		PVD at 1 Mo		PVD at 1 Y		
Age Group	Eyes (n)	Mean Age (Y)	Partial	Complete	Partial	Complete	Partial	Complete	No PVD at 1 Y
<60 years	16	54.6	0	0	2 (12.5)	1 (6.3)	0	0	13 (81.3)
61–80 years	35	70.5	7 (20.0)	4 (11.4)	7 (20.0)	3 (8.6)	3 (8.6)	1 (2.9)	10 (28.6)
≥81 years	6	83.0	0	0	4 (66.7)	1 (16.7)	0	0	1 (16.7)

PVD = posterior vitreous detachment

Postoperatively, 34 (58.7%) of 58 eyes without preoperative echographic signs of PVD developed partial PVD (24 eyes) or complete PVD (10 eyes) within 1 year. Table 2 shows the postoperative PVD occurrences over time. Table 3 shows the development of PVD by age group.

The mean AL was 23.22 mm (range 20.50 to 26.04 mm). There were no statistically significant differences in the incidence of PVD between the 3 AL groups (Table 4).

There were no statistically significant associations between preoperatively measured parameters (age, sex, spherical equivalent, effective phacoemulsification time) and the occurrence of PVD after phacoemulsification and PC IOL implantation.

DISCUSSION

The techniques of cataract surgery have significantly improved over the past decades. The improvements are the result of the development of less traumatizing methods such as phacoemulsification and no-stitch, clear corneal approaches. Retinal detachment caused by vitreous alterations can occur after cataract surgery. It is likely that if there is no PVD before cataract surgery, PVD will develop in many patients postoperatively.[5–8] However, it is important to distinguish between aphakic and pseudophakic surgery with IOL implantation in the bag as well as between ECCE and phacoemulsification cases. In this study, we assessed the occurrence of PVD 1 week, 1 month, and 1 year after phacoemulsification with PC IOL implantation in 58 patients who had no signs of PVD preoperatively. Under physiological conditions, PVD is the consequence of changes in the macromolecular structure of the vitreous gel that result in liquefaction and lowered vitreoretinal adhesion at the vitreoretinal surface and are caused by alterations in the extracellular matrix.[13] This allows the posterior vitreous cortex to detach from the internal limiting membrane of the retina. Posterior vitreous detachment can be focal or extensive; the vitreous can separate completely from the posterior pole or remain attached to the optic disc, producing a funnel-shaped configuration. Under physiological conditions, PVD occurs without complications when weakening of vitreoretinal adhesion and vitreous liquefaction occur at similar times and to a similar extent.[13] Although PVD is a complication of low clinical relevance, its occurrence underlies that the architecture of the ocular globe is somehow affected by the cataract surgery procedure. Posterior vitreous detachment does not directly threaten vision. Even so, it is of increasing interest because the interaction between the vitreous body and the retina might play a decisive role in the development of major pathologic vitreoretinal conditions.[14]

The concept of anomalous PVD has been presented and discussed among scientists.[13] When the extent of

Table 4. Development of PVD (partial and complete) by AL.

		Eyes (%)						
		PVD at 1 Wk		PVD at 1 Mo		PVD at 1 Y		
AL (mm)	Eyes (n)	Partial	Complete	Partial	Complete	Partial	Complete	No PVD at 1 Y
<22.01	6	1 (16.7)	1 (16.7)	1 (16.7)	1 (16.7)	1 (16.7)	0	1 (16.7)
22.01–24.00	31	1 (3.2)	3 (9.7)	10 (32.3)	1 (3.2)	1 (3.2)	0	15 (48.4)
24.01–27.00	9	2 (22.2)	0	1 (11.1)	2 (22.2)	1 (11.1)	0	3 (33.3)

AL = axial length; PVD = posterior vitreous detachment

vitreous liquefaction exceeds the weakening of the vitreoretinal adherence, anomalous PVD can occur and traction is applied at the vitreoretinal interface. The consequences of anomalous PVD include retinal tears and detachment (vitreous base), aggravation of retinal neovascularization, and vitreomacular traction syndrome (posterior pole) when vitreoschisis occurs.[13] In the opposite case, it appears possible that weakening of the vitreoretinal adherence progresses more than vitreous liquefaction, leading to an attached, but loose, vitreous body that can detach easily by low traction power, resulting in PVD.

Our results showed a 1-year incidence of PVD of 58.6% (34/58 eyes) in eyes without preoperative PVD. This is consistent with the results of Ripandelli et al.,[15] who found a PVD incidence of 78.7% within 5 years after cataract surgery. In our study, 82.4% of patients (n = 28) developed PVD after cataract surgery within the first postoperative month. This observation reinforces the presumed association between the occurrence of PVD and cataract surgery.

The reasons for an increased incidence of PVD after cataract surgery remain unknown. Various theories have been put forth. Anterior movements of the vitreous, which can occur after removal of the lens, might play a role in the development of PVD.[5,12,16,17] Dynamic traction at the posterior border of the vitreous base may be caused by forward movements of the vitreous and result in a higher risk for retinal tear formation.[18–21] Protuberance of the posterior surface of the crystalline lens could reduce vitreous traction on the peripheral retina during the ocular saccades.[18–20]

Osterlin et al.[8] found lower concentrations of hyaluronic acid in aphakic eyes than in phakic contralateral eyes in humans. This finding suggests the posterior capsule plays a role in maintaining the colloidal structure of the vitreous. The loss of hyaluronic acid could lead to vitreous instability and increase the risk for PVD. Neal et al.[7] examined the vitreous humor in pseudophakic and phakic human donor eyes by comparing the proteome, viscosity, and size distribution of macromolecules in different regions of the vitreous body. They found that in no case did the phakic donor eyes show the same alteration in the vitreous humor proteome, viscosity, or particle size as that in the pseudophakic eyes. They hypothesized that changes in the microenvironment of the retina may contribute to the development of retinal complications.

In addition to cataract surgery, researchers have observed increased rates of PVD after other ocular surgery such as laser in situ keratomileusis.[22,23] Thus, we hypothesize that ultrastructural changes to the vitreous body by introduction of foreign substances (eg, BSS or OVD) and mechanical changes in ocular globe shape during surgery may accelerate the occurrence of PVD.

With respect to age, PVD after cataract surgery was more frequent in older patients in our study. Posterior vitreous detachment developed within 1 year after surgery in 18.8% of patients younger than 60 years, 71.4% of those 61 to 80 years old, and 83.3% of those 81 years and older. A limitation of this finding is that the sample sizes of the groups were small. Ripandelli et al.[15] suggest that age is not a predominant risk factor for the development of postoperative PVD; they found no statistically significant differences between different age groups.

Regarding our results on the role of AL as a potential risk factor for development of PVD after cataract surgery, again the number of patients in each group was limited.

In addition, the number of eyes evaluated was small to allow the determination of risk factors for PVD associated with cataract surgery. Therefore, further studies with a high number of participants are necessary to determine the factors associated with an increased risk for PVD.

In this study, we used B-scan ultrasonography to determine vitreous status and the presence of a PVD. Hoehn et al.[24] showed that a combination of optical coherence tomography (OCT) and B-scan ultrasonography is needed to prove the attachment of the posterior hyaloid because very shallow PVDs can be missed when ultrasonography is used alone. Therefore, some cases with a flat PVD may have been missed because we did not perform OCT in all cases. Another limitation of this study is that we did not have a matched control group.

The results in this study offer quantitative evidence that supports the clinical observation of many clinicians, which is that several patients report new occurrences of vitreous floaters soon after an uneventful cataract surgery and that a few develop retinal tears or retinal detachment during the early postoperative period. As shown in our study, these clinical observations may be explained by surgery-related PVD in the early postoperative period.

Based on our results, we believe that knowledge of the likelihood, symptoms, and consequences of PVD after cataract surgery is of value to both clinicians and patients.

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