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Evaluation of the Changes in Anterior Segment Morphology with Ultrasound Biomicroscopy after Vitrectomy without Use of Tamponade in Pseudophakic Eyes

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Abstract

Aim: In this study we investigated the changes in anterior segment morphology in pseudophakia patients that underwent ultrasound biomicroscopy (UBM) after pars plana vitrectomy (PPV) operation without use of tamponade. **Method:** Pseudophakic patients who undergo PPV were enrolled in this prospective study between October 2012 and April 2015. Study included patients in whom intraocular tamponade was not used during PPV operation. UBM measurements were performed both before and 10 days after the operation. Anterior chamber depth (ACD) was measured using axial images of anterior segment. Trabecular meshwork-iris angle (TIA), ciliary body thickness (CBT), sclera thickness (ST), trabecular meshwork-ciliary process distance (T-CPD), iris-ciliary processes distance (I-CPD), and iris thickness (IT) were measured at temporal quadrant based on radial section images of the angle. Values measured before and after the operation were statistically compared with each other. **Results:** This study included 30 patients (18 females, 12 males) that underwent an operation ultrasound biomicroscopy (UBM) after pars plana vitrectomy (PPV) operation without use of tamponade. Mean age was 69.6 ± 9.1 (55 - 85) years. Eighteen operations occurred on the left eye whereas twelve operations occurred on the right eye. CBT1, CBT2, CBT Max, T-CPD, and I-CPD were significantly decreased after operation when compared with the values of baseline (before) ($p = 0.018$, $p = 0.012$, $p = 0.001$, $p = 0.033$, $p = 0.015$, respectively). Other evaluated parameters did not show statistically significant changes after the operation ($p > 0.05$). **Discussion:** PPV results in significant changes in ciliary body morphology together with changes in anterior segment parameters in pseudophakic cases.

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Keywords

Ultrasound Biomicroscopy (UBM), Vitrectomy, Pseudophakic Eye, Anterior Segment, Ciliary Body

1. Introduction

The ultrasound biomicroscope is an imaging instrument used in clinical opthalmology that was developed by Palvin in 1990 for use in clinical ophthalmology research [1]. Ultrasound biomicroscopy (UBM) is a non-invasive diagnostic procedure developed in order to achieve superior visualization of the anterior segment of the eye.

UBM is being used for examining anterior segment structure but can also be useful for detection of pathologies present at posterior segment structures like peripheral retina and ciliary body [2]. It provides sectional images of peripheral retina, parsplana and vitreus base, and it remains an important imaging method for treatment of vitreoretinal diseases [3].

Pars plana vitrectomy (PPV) is considered a standard surgical approach in many vitreoretinal diseases. However, PPV can lead complications, some of which arise from the changes in anterior segment morphology [4]-[11].

In this study, we aimed to investigate the changes in anterior segment morphology in pseudophakic patients that underwent PPV operations without use of tamponade.

2. Methods

This study included seventy-five pseudophakic eyes of 75 patients whom underwent PPV operation that were examined prospectively between October 2012 and April 2015. Patients were excluded if gas or silicone oil was used as intraocular tamponade during PPV. The study included 30 eyes in 30 patients for statistical evaluation.

The study conformed to Helsinki Declaration. All participants were provided with information about the procedure, and informed consent was obtained from all patients. Study was approved by local ethical committee.

All patients underwent complete ophthalmological examination before the operation. Patients provided detailed anamnesis; age, sex, any systemic disease or if present, used medications were recorded. Refractions of patients were determined together with best far-sight acuity corrected for Snellen chart. Intraocular pressure (IOP) was measured with Goldmannapplanation tonometer. Goldmann 3 mirror lens was used for the evaluation of the anterior chamber angle.

Study exclusion criteria were as followed: history of uveitis and glaucoma prior to operation, use of topical or systemic drugs that would interfere with pupil or accommodation, previous intraocular operation other than for cataracts, cases in whom IOL was placed outside of the capsule, previous anterior segment laser surgery, previous PPV with scleral depression and subjecte with IOP below 10 mmHg or above 22 mmHg.

Intravitreal injection of 1.25 mg/0.05ml bevacizumab (Avastin; Genentech Inc. South

San Francisko, Calif., USA) was administered nearly one week before the operation in 10 patients with (IVH) due to diabetic retinopathy (DR). 2 patients with chronic significant cystoid macular edema (CSCME) and 3 patients with intravitreus hemorrhage secondary to branch retinal vein occlusion (BRVO-IVH).

All operations were performed with the same surgical protocol and by the same surgeon. PPV was performed with BIOM non-contact wide angle imaging system (Oculus, Germany). Presence of posterior hyaloid was checked with the help of triamcinolone acetonide and if not detached. It was elevated and cleaned by applying vacuum with the tip of vitrectomy probe. Peripheral vitrectomy was performed with scleral depression. Panretinal photocoagulation was completed in all IVH cases due to DR. For BRVO-IVH cases, adequate photocoagulation was applied to the quadrant with occluded vein. Scleral entry sites were sutured when necessary. After the operation, all patients were prescribed prednisolone acetate and lomefloxacin eye drops to be applied once in every 2 hours.

UBM examinations were performed 24 - 48 hours before operation and at least 10 days (10 - 20 days) (13 ± 4 days) after the operation by a single observer using the same device (SONOMED VuMAX II®) and 35 MHz probe attached to this device to minimize variable repeatability. All measurements were performed between 9 - 12 a.m. All UBM examinations were performed within the frame of the protocol that provided standard environments and other settings. Images were obtained in dimly lit room, in supine position, in order to achieve natural pupillary dilatation and by having the patient fixate on a red colored target hanging from the ceiling. This helped controlling the environmental factors that could interfere with the anatomy of the anterior segment and angle.

After 10 - 15 seconds from dropping topical proparacaine HCl %0.5 (Alcaine®, Alcon) to the eye, soft silicone eye-cup at an appropriate diameter was placed between upper and lower lid conjunctival fornices. Measurements before and after the operation were performed using the same eye-cups in all patients. Probe focus distance was set at 12 mm in order to avoid contact to cornea, and the scanning was done after inside of the eye-cup was filled with adequate amount of sterile serum physiologic for the purpose of immersion.

Axial images of the anterior chamber were obtained first, followed by radial section images of the angle from the temporal quadrant. In order to obtain ideal images and consistency in later measurements, we had balanced images (aligned with theoretical central horizontal line and symmetrical) during axial scanning of the anterior segment and for the order of vertical line (cornea. lens. anterior and posterior capsule references balanced on theoretical vertical central line). To be able to select images of the iris that yielded the best reflectivity during radial section images of the angle, the handle was directed perpendicular to limbal region at the scanned quadrant. We tried to make sure that intermediate surface reflectance between ciliary body and sclera was prominent, and images of ciliary body and iris were in good quality for accurate and easy localization of the scleral spur [12].

Based on the axial images of the anterior segment, central axial ACD and lens thickness were measured by the method previously recommended by Pavlin *et al.* using scales that were present within the device's own software [13] [14].

1) Axial ACD measurement was performed by measuring the distance between central corneal posterior surface and anterior IOL surface (**Figure 1(A)**).

Next, following measurements were performed based on radial section images of the angle at temporal quadrant;

2) Trabecular Meshwork-Irıs Angle (TIA), an angle measured with the apex in the iris recess and the arms of the angle passing through a point on the trabecular meshwork 500 μm from the scleral spur and the point on the iris perpendicularly (**Figure 1(B)**).

3) Ciliary body thickness (CBT) was measured from four areas:

a) at a distance 1 mm from scleral spur (CBT 1) (**Figure 1(C)**).

b) at a distance 2 mm from scleral spur (CBT 2) (**Figure 1(D)**).

c) at a distance 3 mm from scleral spur (CBT 3) (**Figure 1(E)**).

d) at the thickest part of ciliary body (CBT Max) (**Figure 1(F)**).

4) Scleral thickness (ST) was measured perpendicular to scleral spur between episcleralsurface (**Figure 1(G)**).

5) Trabecular-ciliary process distance (T-CPD) was measured as the distance between a point 500 μm from the scleral spur and the ciliary process on the line that is perpendicular through the iris (**Figure 1(H)**).

6) Iris-ciliary process distance (I-CPD) was measured as the distance from the iris pigment epithelium to ciliary processes (**Figure 1(I)**).

7) Iris Thickness (IT) was measured from three zones:

a) IT-1: on the line at T-CPD (**Figure 1(J)**).

b) IT-2: at a distance 2 mm central from iris root (**Figure 1(J)**).

c) IT-3: from the thick area next to the pupillary border (**Figure 1(J)**).

All UBM examinations and measurements were repeated at least 10 days (10 - 20 days) after the operation and compared to values before operation. Statistical analysis was performed with "SPSS 15.00 for Windows" (SPSS Inc., Chicago, İllinosis, USA.) software.

Values measured before and after the operation were evaluated statistically with Paired-Samples T Test. Results were evaluated at 95% confidence interval and $p < 0.05$ was considered significant different.

3. Results

Thirty patients, 18 female and 12 male were enrolled in the study. Operations on 18 left eyes and 12 right eyes were performed without use of intraocular tamponade. The mean age of the patients was 69.6 ± 9.1 (55 - 85) (**Table 1**).

Ten patients had intravitreal hemorrhage (IVH) due to DR. 2 patients had chronic significant cystoid macular edema. 3 patients had IVH due to branched retinal vein occlusion, and 15 patients had idiopathic epiretinal membrane (ERM) (**Table 1**).

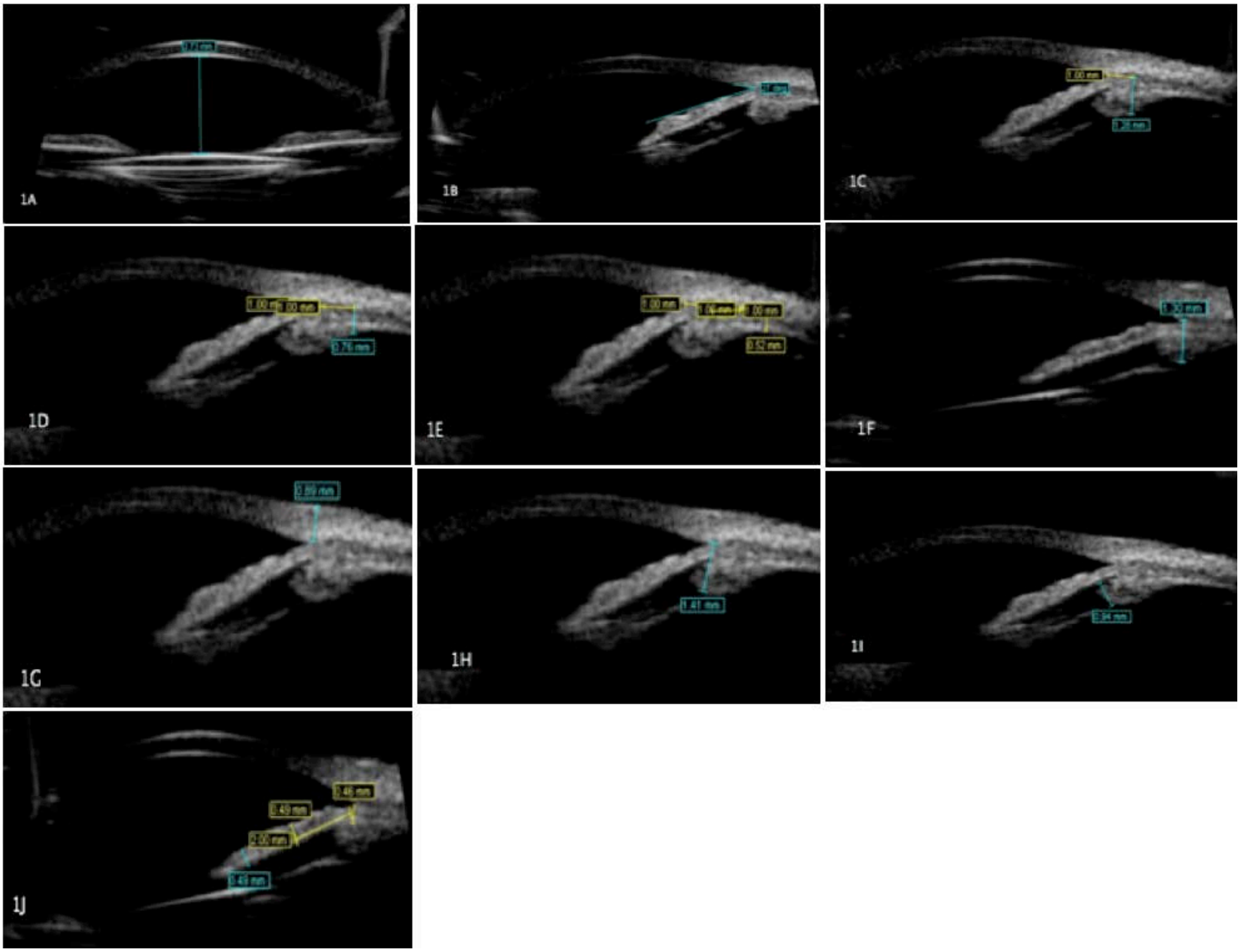

Figure 1. Views of axial images of the anterior chamber and radial section of the angle images from the temporal quadrant. (A) An UBM image of Anterior Chamber Depth (ACT); (B) An UBM image of Trabecular Meshwork-Iris Angle (TIA); (C) An UBM image of Ciliary Body Thickness 1 (CBT 1); (D) An UBM image of Ciliary Body Thickness 2 (CBT 2); (E) An UBM image of Ciliary Body Thickness 3 (CBT 3); (F) An UBM image of Maximum Ciliary Body Thickness (CBT Max); (G) An UBM image of Scleral Thickness (ST); (H) An UBM image of Trabecular-Ciliary Process Distance (T-CPD); (I) An UBM image of Iris-Ciliary Process Distance (I-CPD); (J) An UBM image of Iris Thickness 1. 2. 3 (IT-1. 2. 3).

CBT1, CBT2, CBT Max, T-CPD and I-CPD were significant decrease after the operation as compared to preoperative values ($p = 0.018$, $p = 0.012$, $p = 0.001$, $p = 0.033$, $p = 0.015$, respectively) (Table 2).

However other evaluated parameters did not show significant difference after the operation ($p > 0.05$) (Table 2).

4. Discussion

In this study, the mean values of CBT1, CBT2, CBT Max, T-CPD and I-CPD were significantly different 10 days after PPV operation without use of tamponade in pseudophakic patients when compared to preoperative values.

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Table 1. Demographics and clinical characteristics of the patients.

Eye number	30
Gender (M/F)	12/18
Mean age ± SD (range)	69.6 ± 9.1 (55 - 85)
Right/left eye	12/18
DR-IVH/DR-CSCME/BRVO-IVH/ERM	10/2/3/15

Abbreviations: SD: standard deviation; M: Male; F: Female; DR-IVH: intravitreus hemorrhage secondary to diabetic retinopathy; DR-CSCME: chronic significant cystoid macular edema secondary to diabetic retinopathy; BRVO-IVH: intravitreus hemorrhage secondary to branch retinal vein occlusion; ERM: epiretinal membrane.

Table 2. Comparison of the pre-operative and post-operative parameters of the anterior segment and the angle of the temporal quadrant.

	Pre	Post	p*
ACD (mm)	3.71 ± 0.63 (2.49 - 4.96)	3.56 ± 0.52 (2.69 - 4.64)	0.277
TIA (˚)	33.9 ± 3.84 (28.0 - 39.0)	33.8 ± 6.11 (27.0 - 46.0)	0.945
CBT 1	1.03 ± 0.14 (0.85 - 1.34)	0.93 ± 0.23 (0.46 - 1.36)	0.018
CBT 2	0.62 ± 0.16 (0.42 - 1.09)	0.57 ± 0.16 (0.33 - 0.96)	0.012
CBT 3	0.36 ± 0.05 (0.29 - 0.46)	0.32 ± 0.11 (0.24 - 0.62)	0.070
CBT Max	1.22 ± 0.10 (1.10 - 1.41)	1.10 ± 0.19 (0.76 - 1.46)	0.001
ST	0.98 ± 0.09 (0.80 - 1.13)	1.03 ± 0.07 (0.91 - 1.15)	0.060
T-CPD	1.38 ± 0.17 (1.13 - 1.67)	1.29 ± 0.12 (0.96 - 1.44)	0.033
I-CPD	0.93 ± 0.17 (0.65 - 1.18)	0.83 ± 0.13 (0.57 - 1.07)	0.015
IT-1	0.49 ± 0.05 (0.40 - 0.55)	0.49 ± 0.07 (0.40 - 0.63)	0.951
IT-2	0.48 ± 0.03 (0.43 - 0.54)	0.49 ± 0.06 (0.39 - 0.64)	0.153
IT-3	0.56 ± 0.05 (0.45 - 0.66)	0.55 ± 0.13 (0.34 - 0.88)	0.871

ACD: Anterior chamber depth; TIA: Trabeculer meshwork-iris angle; CBT 1. 2. 3: Ciliary body thickness 1. 2 and 3 mm. CBT Max: Maximum Ciliary body thickness; ST: Sclera thickness; T-CPD: Trabecular meshwork-ciliary process distance; I-CPD: Iris-ciliary process distance; IT-1.2.3: Iris thickness 1.2.3; *Paired-Samples T Test.

Repeatability, accuracy and sensitivity of measurements related to UBM have been investigated [15]. To take ideal images with UBM, the observer needs to have adequate experience so that the variation in the measurements are good [16]. The underlying reasons for this variation are mainly differences in selection of the image that is used for measurement and detection of the localization of scleral spur. Therefore, it is recommended that the same observer perform comparisons of the measurements before and after any intervention. For this reason, the same observer (EÜ) is used to UBM measurements before and after the operation, and data for comparison in this study.

Evaluation of the anterior chamber angle with UBM can be interfered by image taking quality and variations in analysis, and also by physiological variables. Illumination of the room, fixation and accommodative effort are factors effecting anterior segment anatomy. Therefore should be kept constant while performing quantitative measurements. Our measurements were performed within a frame of a protocol that provided standard environment and settings.

Calik *et al.* performed PPV in 22 cases with silicon oil internal tamponade and in 22 cases without tamponade [17]. However the number of phakic and pseuphakic cases were not reported. The Pentacam Scheimpflug method was used to evaluate anterior segment structures before operation, one week and one month after the operation. In the group without tamponade use, mean ACD was 2.99 mm before operation, decreased to 2.40 mm at the first week and to 2.64 mm at the first month after the operation, but the difference was not statistically significant. Our study comprised of cases with pseudophakia. Although mean ACD dropped down after the operation from 3.71 mm to 3.56 mm. the decrease was not significant different. In that same study. TIA was 33.6˚ before operation, and increased to 35.0˚ one week after operation and 34.5˚ one month after the operation, but this increase was not statistically significant. In our study, TIA was not sigfniciantly different (33.9˚ before the operation. 33.8˚ after the operation)

Neudorfer *et al.* evaluated changes in anterior segment using high frequency UBM both before and 1 - 2 days after PPV operation in 28 cases. 18 phakic and 10 pseudophakic [18]. In the subgroup of 13 cases consisting of phakic and pseudophakic cases for whom internal tamponade was not used. ACD value dropped after surgery but did not reached statistically significant differences (3.34 mm preoperatively. 3.29 mm after the operation). In our study we also did not had significant change in ACD.

In that same study. Neudorfer *et al.* found correlation between increased IOP and ACD. In our study, patients with IOP below 10 mmHg and above 22 mmHg were excluded [18].

Kim *et al.* evaluated CBT with UBM before and after PPV in patients with diabetic macular edema (DME) [19]. Before operation, the mean CBT in DME group was significantly higher than in the control group and idiopathic ERM group. Although CBT decreased significantly in DME group after operation, there was no significant change in ERM group. CBT is increased in patients with DME due to the edema, and shows significant decrease with vitrectomy as the edema in ciliary body is reduced along with the decrease in macular edema. In our study, a significant portion of our patients had complication due to DR. and we found significant decreases in mean CBT1.CBT2 and CBT Max values after the operation. In our study, 15 patients received anti-VEGEF injection approximately one week before the operation. Intravitreal anti-VEGEF injection is known to cause decrease in DME [20] [21] [22] [23]. Similarly, it can cause decrease in CBT due to reduced edema. Additionally, vitreal VEGF levels have been shown to decrease after PPV [24] [25] [26]. In our study, 15 patients received intraoperative laser photocoagulation which can lead to decrease in retinal thickness [27] [28]. The decrease of CBT in our study can be a result from a combination of effects of 1) decreased intravitreal VEGEF concentration after vitrectomy, 2) application of anti-VEGEF before operation and 3) laser photocoagulation during operation.

Marigo *et al.* evaluated anterior segment morphology with UBM before vitrectomy operation and one month after operation in a study group consisting of 20 patients. They reported no significant change in anterior segment morphology [29]. This study included both phakic and pseudophakic patients. whereas our study consisted of pseudophakic patients only. In addition, it is not clear whether intravitreal anti-VEGEF injection was administered or not before the operation whereas 15 patients in our study, had received anti-VEGEF injection.

We did another study to evaluate the morphological changes of the anterior segment using UBM imaging in phakic patients who underwent PPV without internal tamponade agent [30]. In this study, patients who underwent PPV without internal tamponade agent injection at the phakic eyes, postoperative mean values of TIA were found to be significantly increased. Although pseudophakic patients who underwent PPV without internal tamponade agent injection were found to be unchanged. This may be related to the spherical structure of posterior surface of lens inside the eye. At the both of the study, patients who underwent PPV without internal tamponade agent, postoperative mean values of CBT, and T-CPD, according to preoperative values, were found to be significantly reduced [30].

There are limitations in this study 1) Evaluation with UBM examination was not repeated at later periods after the examination at early postoperative period (10th day); 2) The study group consisted of psudophakic cases only; 3) No control group was evaluated; 4) the study population included patients with different diagnoses; 5) measurement with UBM was only performed axially and at temporal quadrant, and not repeated at other quadrants.

5. Conclusion

PPV effects anterior segment morphology significantly. Studies utilizing more advanced devices, including large number of cases whom have the same diagnosis are necessary in order to understand the effects of PPV on anterior segment morphology better.

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Conflict of Interest Statement

None of the authors has conflict of interest with this submission.

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