Int Ophthalmol (2025) 45:312
https://doi.org/10.1007/s10792-025-03663-7

ORIGINAL PAPER

Anterior chamber alterations in fellow eyes of face-down positioned patients after pars plana vitrectomy: a prospective longitudinal study

Gozde Sahın Vural · Yurdagul Gırgın · Yucel Yıgıt · Eyyup Karahan

Received: 23 February 2025 / Accepted: 28 June 2025 / Published online: 23 July 2025
© The Author(s), under exclusive licence to Springer Nature B.V. 2025

Abstract

Purpose To compare the anterior chamber (AC) changes in fellow eyes of patients who were directed to a face-down position after pars plana vitrectomy (PPV).

Methods The bilaterally phakic patients who had PPV, and were advised prone position due to intraocular tamponade for at least three days were included. The AC properties such as central anterior chamber depth (ACD), and ACD and anterior chamber angle (ACA) in nasal, and temporal quadrants and the intraocular pressure (IOP) were recorded at the preoperative visit, 1st-day, last day of prone position, and 1st-month visits in both eyes.

Results The study included 51 eyes of 51 patients with a mean age of 60.3 ± 13.5 years. Mean IOP had a significant increase on 1st day (Preoperative IOP 14.9 ± 3.5 mmHg, and IOP on 1st day: 16.4 ± 3.7 mmHg ($p = 0.021$)). Mean ACD in all quadrants were significantly narrowed on 1st day and last face-down day ($p < 0.001$, for all) while ACA in all quadrants were significantly narrowed similarly ($p < 0.001$, for all parameters) compared to the preoperative period.

Conclusion The face-down position in fellow eyes of PPV-operated patients may lead to significant anterior chamber narrowing resulting in IOP peaks. The patients should be carefully monitored for possible angle-closure glaucoma. This study was approved by the institutional review board (Registration Number and Date: 2021/60 and 24.02.2021).

Keywords Anterior chamber depth · Anterior chamber angle · Face-down position · Pars plana vitrectomy

G. Sahın Vural (✉) · Y. Gırgın · Y. Yıgıt
Department of Ophthalmology, Balıkesir University, Balıkesir, Turkey
e-mail: gozdejcgrl@hotmail.com

E. Karahan
Special Ophthlamology Clinic, Balıkesir, Turkey

Introductıon

Secondary glaucoma after vitreoretinal surgeries is a challenging condition despite improved surgical techniques. Related to the surgical method, such as pars plana vitrectomy (PPV) [1], scleral buckling [2], intravitreal injections, or related to the intraocular tamponade, such as silicone oil [3] or expandable gases [4], and also postoperative face-down (prone position) may contribute a significant rise in intraocular pressure (IOP). The underlying mechanism for increased IOP should be lightened, as the management of glaucoma can differ due to the causes [5]. The resistant nature of glaucoma, unresponsiveness to standard medications, and also combined retina and optic nerve/field involvement may complicate the condition and may lead to poor visual outcomes despite excellent surgeries [6].

Especially in rhegmatogenous retinal detachment (RRD) secondary to retinal tears, surgical success depends on the appropriate coverage of retinal tears with intraocular tamponade. Similarly, after macular surgeries, the integrity of fovea can be ensured by providing the appropriate position of the tamponade. Most of the cases after PPV required a strict face-down position [7–10], while some authors showed a similar success rate with a supine position without the additional risk of anterior chamber complications [11, 12].

The face-down position, which is required not only after PPV but also for different treatments such as ventilation for severe coronavirus disease (COVID-19) pneumonia, can lead to acute angle-closure glaucoma [13]. The IOP rise may affect the both anterior segment and retina, or optic disc that may lead to changes in ocular perfusion pressure. As a result, progressive and irreversible vision loss may occur due to ischemia. The underlying mechanism can be related to angle-closure or orbital compartment syndrome in both eyes.

In the light of these information, the aim of the study is to evaluate the anterior chamber alterations in fellow eyes of PPV-operated eyes after a face-down position. To the best of our knowledge, this study will be the first to examine the changes in the anterior chamber structure in the other healthy eyes of patients who underwent the prone position after PPV.

Methods

This prospective study was conducted in Balıkesir University Medicine Faculty between March 2021–2023. The study adhered to the tenets of the Declaration of Helsinki, and it was approved by the institutional review board (Registration Number and Date: 2021/60 and 24.02.2021). The participants informed about the study, and the informed consent was obtained from all. Bilaterally phakic patients who have underwent unilateral PPV for various indications such as tractional detachment, vitreous hemorrhage, RRD, epiretinal membrane, macular hole, etc., and advised prone position due to intraocular tamponade for at least three days were included. A single vitreoretinal surgeon (E.K.) performed all surgeries.

The demographic data, and accompanying systemic disease & treatments were recorded, following a routine ophthalmological examination including best-corrected visual acuity (BCVA) (with Snellen Chart adjusted at 5 m, in decimals), IOP (via Goldmann applanation tonometer), and direct/indirect ophthalmoscopic fundus examination through a contact lens were completed. The indication for PPV, and type of intraocular tamponade were recorded. The axial length (AL), anterior chamber depth (ACD) in central, nasal, and temporal quadrants, nasal & temporal anterior chamber angle (ACA), and central corneal thickness (CCT) were recorded at the preoperative visit, on the 1st-day, at the last day of prone position, and at the 1st-month visits. The AL was measured through optic biometry (IOL Master 500, Zeiss, Germany). The ACD and ACA were evaluated by using combined Placido disc corneal topography and Scheimpflug camera to obtain the corneal morphology and anterior chamber structures via corneal tomography (CSO Sirius, Florence, Italy). Three repetitive measurements by the same technicians were recorded, and the mean values were accepted as valid. The whole measurements were completed in PPV-operated eyes and the unoperated fellow eyes.

The exclusion criteria were eyes with scleral buckling, and those with no anatomical success of retinal disease, pseudophakia, angle-closure glaucoma or glaucoma suspect, history of corneal or refractive surgery or other types of intraocular surgeries, corneal disease such as keratoconus, being under the age of 18, the refractive error above 2.00 Diopters (D), reoperation required after immediate postoperative phase, pre/postoperative synechia, media opacities that prevents accurate ACD measurement, asymmetry in anterior chamber morphology, AL, and corneal thickness, complication during PPV, poor patient incompliance to face-down position, eyes with missing data. Patients with bilateral PPV history were also excluded.

Statistical analysis

Statistical analysis was performed using SPSS software (IBM SPSS Statistics for Windows, Version 23.0, IBM Corp., Armonk, NY). The sex distribution was analyzed by Chi-square test among groups. The difference in parameters during follow-ups were evaluated with paired t-test. The numerical parameters of the PPV + and fellow eyes were compared by independent t-test. The Pearson correlation analysis was

performed to analyse the correlation between IOP rise, ACD and ACA changes after PPV and the other parameters. P-value of < 0.05 was considered statistically significant.

Results

The data of 59 patients were investigated. None of the patients had intraoperative complications during PPV. After strict exclusion criteria, three patients with bilateral tractional retinal detachment, two patients with bilateral RRD, one patient with degenerative myopia, one patient with unilateral phthisis bulbi, and one patient with PPV history for IVH were excluded. Finally, 51 unoperated eyes (PPV-) of 51 patients with a mean age of 60.3 ± 13.5 years (33 male, 18 female) were included. The indications for PPV were summarized in Graph. 1. At the end of PPV, the preferred intraocular tamponade agent was silicone oil in 66.6% (n = 34), gases in 29.4% (n = 15) (C_3F_8 in 21.5%, SF_6 in 7.8%), air in 3.9% (n = 2) of operated eyes.

Preoperative mean IOP was 14.9 ± 3.5 mmHg, and mean IOP value on day 1 was 16.4 ± 3.7 mmHg ($p = 0.021$). An increase in IOP above 5 mmHg was detected in 9 patients (17.6%). In 6 of these 9 patients, temporary antiglaucomatous drop treatment was performed because the IOP value on day 1 was above 21 mmHg. One patient had severe pain and vision loss in both eyes on the 1st-day visit. In the PPV- eye the preoperative IOP value was 15 mmHg, while the IOP value on the 1st day was 41 mmHg. The anterior chamber was narrow and none of the anterior chamber angle structures could be seen by gonioscopy. The anterior chamber was narrow in the operated eye of this patient, and the IOP was measured as 38 mmHg. Under the diagnosis of bilateral AACG, the patient received systemic treatment with intravenous 15% mannitol and 500 mg oral acetazolamide hydrochloride as well as topical therapy with timolol-dorzolamide fixed combination, brimonidine and 2% pilocarpine and the IOP decreased to 18 mmHg in PPV + and 12 mmHg in the PPV—eyes. After IOP and pain control with medical therapy, laser peripheral iridotomy on both eyes was performed. After laser iridotomy, prone lying position was continued for 4 more days.

The mean central, nasal, and temporal ACDs on the 1st-day and the last day of the prone position were significantly narrow compared to the preoperative values. ($p < 0.001$ and $p = 0.008$, respectively). There was no difference between the mean anterior chamber values in the first month and the preoperative values.

The mean anterior chamber angles in the nasal and temporal quadrants ($p = 0.011$ and $p = 0.026$, respectively) were found to be significantly narrower on the 1st day and the last day of the prone position compared to the preoperative period. There was no significant difference between the mean anterior chamber angle values in the first month

Table 1 Preoperative and postoperative IOP, CCT, ACD, ACA of the fellow eyes of the patients

	Preop	1. day	The last day of face-down position	1. month	p1 (preop vs 1.day)	p2 (preop vs last face-down day)	p3 (preop vs 1. month)
IOP (mmHg)	14.90 ± 3.60	16.35 ± 3.69	15.69 ± 3.73	16.06 ± 3.51	0.020*	0.300	0.628
CCT (µm)	527.2 ± 49.8	535.1 ± 45.3	535.2 ± 54.4	535.3 ± 44.6	0.069	0.706	0.426
ACD central (µm)	2.69 ± 0.52	2.53 ± 0.45	2.50 ± 0.41	2.61 ± 0.47	< 0.001*	< 0.001*	0.262
ACD nasal (µm)	2.64 ± 0.58	2,29 ± 0.63	2.21 ± 0.46	2.52 ± 0.38	< 0.001*	< 0.001*	0.121
ACD temporal (µm)	2.48 ± 0.48	2.12 ± 0.54	2.22 ± 0.66	2.45 ± 0.46	< 0.001*	< 0.001*	0.644
ACA nasal (µm)	41.52 ± 10.14	35.27 ± 8.35	37.58 ± 8.87	41.38 ± 7.46	< 0.001*	< 0.001*	0.874
ACA temporal(µm)	40.05 ± 10.17	34.51 ± 10.22	35.88 ± 10.75	40.34 ± 13.33	< 0.001*	< 0.001*	0.546

*Statistically significant ratio. preop: preoperative, *IOP*: Intraocular pressure, *CCT*: Central corneal thickness, *ACD*: Anterior chamber depth, *ACA*:Anterior chamber angle

and the preoperative values. Table 1 shows the IOP, CCT, ACD, and ACA values preoperatively, on 1st-day, on the last prone position day, and on the 1st month.

Changes in ACD in the central, nasal, and temporal regions on the first day and in the first week compared to the preoperative values had a significantly inverse relationship with the preoperative central, nasal and temporal ACDs. The changes in the nasal, and temporal anterior chamber angles on the first day and the first week, according to the preoperative values, had a significant inverse relationship with the preoperative center, nasal and temporal ACDs (Tables 2 and 3).

Discussion

In this study, it was observed that there was a significant increase in IOP of the healthy eyes on the 1st day in the patients lying in the prone position, and the ACD and angle were significantly reduced. In some of the patients, medical treatment was started to reduce IOP in healthy eyes. In one patient, non-obstructive glaucoma occurred in the healthy eye. In the preoperative period, it was determined that the ACD and angle narrowing occurred more in eyes with narrower ACD and ACA. It was observed that the narrowing in ACD and ACA continued until the last day of the prone position. In the first-month examination, it was

Table 2 Relationship between changes in IOP, anterior chamber depth and anterior chamber angle on postoperative day 1, and preoperative axial length and anterior chamber parameters

	AL	ACD central	ACD nasal	ACD temporal	ACA nasal	ACA temporal
Change in IOP (mmHg)	R = −0.068 *p* = 0.500	R = 0.007 *p* = 0.947	R = 0.106 *p* = 0.291	R = 0.150 *p* = 0.132	R = 0.106 *p* = 0.291	R = 0.149 *p* = 0.135
Change in central ACD	R = −0.031 p = 0.758	R = −0.431 p < 0.0001*	R = −0.409 p < 0.0001*	R = −0.206 p = 0.042*	R = −0.169 p = 0.097	R = −0.201 *p* = 0.047*
Change in nasal ACD	R = 0.132 *p* = 0.198	R = −0.365 *p* < 0.0001*	R = −0.602 *p* < 0.0001*	R = −0.299 *p* = 0.003*	R = −0.197 *p* = 0.053	R = −0.223 *p* = 0.028*
Change in temporal ACD	R = 0.036 *p* = 0.724	R = −0.248 *p* = 0.014*	R = −0.307 *p* = 0.002*	R = −0.234 *p* = 0.021*	R = −0.148 *p* = 0.149	R = −0.113 *p* = 0.270
Change in nasal ACA	R = 0.001 *p* = 0.996	R = −0.067 *p* = 0.506	R = −0.017 *p* = 0.865	R = −0.062 *p* = 0.538	R = −0.100 *p* = 0.320	R = −0.085 *p* = 0.399
Change in temporal ACA	R = 0.216 *p* = 0.030	R = −0.202 *p* = 0.043*	R = −0.173 *p* = 0.084	R = −0.206 *p* = 0.039	R = −0.133 *p* = 0.186	R = −0.299 *p* = 0.002*

*Statistically significant, *ACD*: Anterior chamber depth, *ACA*: Anterior chamber angle

Table 3 Evaluation of the relationship between the difference between the last day in prone position and the values in the preoperative period and the preoperative values with Pearson coorelation analysis

	AL	ACD central	ACD nasal	ACD temporal	ACA nasal	ACA temporal
Change in central ACD	R = −0.029 *p* = 0.771	R = −0.395 *p* < 0.0001*	R = −0.040 *p* = 0.688	R = −0.303 *p* = 0.002	R = −0.180 *p* = 0.071	R = −0.355 *p* < 0.0001*
Change in nasal ACD	R = 0.166 *p* = 0.095	R = −0.565 *p* < 0.0001*	R = −0.819 *p* < 0.0001*	R = −0.441 *p* < 0.0001*	R = −0.376 *p* < 0.0001*	R = −0.271 *p* = 0.006
Change in temporal ACD	R = 0.085 *p* = 0.403	R = −0.051 *p* = 0.619	R = 0.017 *p* = 0.871	R = −0.325 *p* = 0.001	R = 0.014 *p* = 0.893	R = −0.199 *p* = 0.049
Change in nasal ACA	R = −0.038 *p* = 0.706	R = −0.161 *p* = 0.107	R = −0.036 *p* = 0.721	R = −0.166 *p* = 0.095	R = −0.234 *p* = 0.018	R = −0.246 *p* = 0.013
Change in temporal ACA	R = 0.056 *p* = 0.578	R = −0.070 *p* = 0.485	R = 0.143 *p* = 0.151	R = −0.064 *p* = 0.525	R = −0.068 *p* = 0.496	R = −0.564 *p* < 0.0001*

*Statistically significant, *ACD*: Anterior chamber depth, *ACA*: Anterior chamber angle

determined that the mean ACD and ACA were at the same level as the preoperative values.

Prone position is recommended for patients who were applied gas or silicone tamponade after PPV to increase the effectiveness of tamponade. It is known that the prone position may cause changes in the anterior segment and IOP, especially in patients with risk groups. In fact, it is one of the most effective methods used to determine the risk of angle-closure glaucoma [14, 15]. Prone position causes anterior shift in the lens-iris diaphragm, obstruction in aqueous humor outflow, and relative pupillary block in these eyes. In the prone provocation test, an increase in IOP above 8 mmHg after 60 min of prone position is considered positive [16].

In the case report of Lin et al., PPV was performed and acute primary angle-closure glaucoma occurred in the other eye of a patient lying in the prone position 1.5 h after the operation. In this patient, IOP was controlled with medical treatment and peripheral iridotomy and hospitalization was continued in the prone position [17]. In a patient who was given C3F8 for macular hole surgery and was placed in prone position, no problem was encountered on the 1st-day control, but bilateral angle-closure glaucoma was observed in the 1st-week control. After medical treatment and laser iridotomy, it was observed that IOP was reduced, but because the iridocorneal angle was still grade 1, cataract surgery was applied to the patient [18]. In another case report, Sutter et al. reported angle-closure glaucoma in the other eye on the 3rd day after PPV [19]. As can be seen, angle-closure glaucoma can occur at different times after the prone position. In the literature, there is no study in which progressive follow-up of IOP and anterior chamber morphology of patients who were placed in face-down position after PPV. In our study, it was observed that there was a significant increase in IOP at 24 h after the prone position in the other eye of the patients who underwent PPV, and the ACD and ACA were significantly narrowed. In the evaluation made on the last day of the lying position, it was determined that the narrowing in ACD and ACA continued without increasing. In the 1st month, it was determined that the ACD and ACA returned to normal. In these patients, there was a significant relationship between postoperative changes in ACD and ACA and preoperative anterior chamber morphology. Eyes with narrower anterior chambers had more narrowing. This shows the importance of determining the risk factors for angle-closure glaucoma preoperatively. It is important to evaluate both eyes of these patients in detail in the preoperative period, and to perform prophylactic iridotomy treatment, if necessary. In addition, in such high-risk patients, especially if tamponade is applied for retinal tears, lying positions other than the prone position should be considered, depending on the location of the tear to be closed. It has been shown that highly successful anatomical results can be obtained with lying positions other than the prone position [11, 12, 20]. In the study reported by Shiraki et al., it was shown that patients with RRD had a higher success rate in patients who were placed in the supine and lateral positions compared to those in the prone position [21].

In our study, ultrasound biomicroscopy could not be performed because it was not available in our clinic. This is a factor that reduces the power of our study. In addition, we are of the opinion that doing it with more cases can increase the power of the study.

As a result, significant changes occurred in anterior segment morphology in the healthy eyes of patients who were placed face down in the postoperative period. In patients undergoing PPV, this information must be taken into account and necessary precautions must be taken.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by GSV, YY, YG, EK, GSV, YY, YG, EK and GSV, YY, YG, EK. The first draft of the manuscript was written by GSV, YY, YG, EK and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing ınterests The authors have no relevant financial or non-financial interests to disclose.

Ethics approval This prospective study adhered to the tenets of the Declaration of Helsinki, and it was approved by the institutional review board (Registration Number and Date: 2021/60 and 24.02.2021).

Consent to participate Informed consent was obtained from all individual participants included in the study.

References

1. Han DP, Lewis H, Lambrou FH et al (1989) Mechanisms of intraocular pressure elevation after pars plana vitrectomy. Ophthalmology 96:1357–1362. https://doi.org/10.1016/S0161-6420(89)32715-1
2. Kreiger AE, Hodgkinson BJ, Frederick AR, Smith TR (1971) The results of retinal detachment surgery. Analysis of 268 operations with a broad scleral buckle. Arch Ophthalmol (Chicago, Ill 1960) 86:385–394. https://doi.org/10.1001/ARCHOPHT.1971.01000010387005
3. Al-Jazzaf AM, Netland PA, Charles S (2005) Incidence and management of elevated intraocular pressure after silicone oil injection. J Glaucoma 14:40–46. https://doi.org/10.1097/01.IJG.0000145811.62095.FA
4. Chang S, Lincoff HA, Coleman DJ et al (1985) Perfluorocarbon gases in vitreous surgery. Ophthalmology 92:651–656. https://doi.org/10.1016/S0161-6420(85)33985-4
5. Balasopoulou A, Kokkinos P, Pagoulatos D et al (2017) Symposium Recent advances and challenges in the management of retinoblastoma Globe - saving Treatments. BMC Ophthalmol 17:1. https://doi.org/10.4103/ijo.IJO
6. Chen SJ, Lu P, Zhang WF, Lu JH (2012) High myopia as a risk factor in primary open angle glaucoma. Int J Ophthalmol 5:750. https://doi.org/10.3980/J.ISSN.2222-3959.2012.06.18
7. Kanclerz P, Grzybowski A (2018) Complications associated with the use of expandable gases in vitrectomy. J Ophthalmol. https://doi.org/10.1155/2018/8606494
8. Kunikata H, Abe T, Nakazawa T (2019) Historical, current and future approaches to surgery for rhegmatogenous retinal detachment. Tohoku J Exp Med 248:159–168. https://doi.org/10.1620/TJEM.248.159
9. Gan N, Lam W-C (2018) Retinal detachments in the pediatric population. Taiwan J Ophthalmol 8:222. https://doi.org/10.4103/TJO.TJO_104_18
10. Liao L, Zhu XH (2019) Advances in the treatment of rhegmatogenous retinal detachment. Int J Ophthalmol 12:660–667. https://doi.org/10.18240/IJO.2019.04.22
11. Chen X, Yan Y, Hong L, Zhu L (2015) A comparison of strict face-down positioning with adjustable positioning after pars plana vitrectomy and gas tamponade for rhegmatogenous retinal detachment. Retina 35:892–898. https://doi.org/10.1097/IAE.0000000000000413
12. Otsuka K, Imai H, Miki A, Nakamura M (2018) Impact of postoperative positioning on the outcome of pars plana vitrectomy with gas tamponade for primary rhegmatogenous retinal detachment: comparison between supine and prone positioning. Acta Ophthalmol 96(2):e189–e194
13. Nerlikar RR, Palsule AC, Vadke S (2021) Bilateral acute angle closure glaucoma after prone position ventilation for COVID-19 pneumonia. J Glaucoma 30:e364. https://doi.org/10.1097/IJG.0000000000001864
14. Hyams SW, Friedman Z, Neumann E (1968) Elevated intraocular pressure in the prone position. A new provocative test for angle-closure glaucoma. Am J Ophthalmol 66:661–672. https://doi.org/10.1016/0002-9394(68)91287-7
15. Neumann E, Hyams SW (1973) Gonioscopy and anterior chamber depth in the prone-position provocative test for angle-closure glaucoma. Ophthalmologica 167:9–14. https://doi.org/10.1159/000306919
16. Harris LS, Galin MA (1972) Prone provocative testing for narrow angle glaucoma. Arch Ophthalmol (Chicago, Ill 1960) 87:493–496. https://doi.org/10.1001/ARCHOPHT.1972.01000020495001
17. Lin Z, Wu R, Moonasar N, Zhou Y (2017) Acute primary angle closure in the fellow eye as a complication of facedown position after vitrectomy surgery. J Glaucoma 26:e5–e6. https://doi.org/10.1097/IJG.0000000000000523
18. Lee CE, Kim YC (2019) Bilateral acute angle-closure glaucoma after macular hole surgery. Korean J Ophthalmol 33:101. https://doi.org/10.3341/KJO.2018.0061
19. Sutter FKP, Smorgon A, McClellan K (2003) Acute angle closure in the fellow eye as a complication of prone positioning after vitreoretinal surgery. Arch Ophthalmol (Chicago, Ill 1960) 121:1057. https://doi.org/10.1001/ARCHOPHT.121.7.1057-A
20. Martínez-Castillo V, Boixadera A, Verdugo A, García-Arumí J (2005) Pars plana vitrectomy alone for the management of inferior breaks in pseudophakic retinal detachment without facedown position. Ophthalmology. https://doi.org/10.1016/J.OPHTHA.2004.12.046
21. Shiraki N, Sakimoto S, Sakaguchi H et al (2018) Vitrectomy without prone positioning for rhegmatogenous retinal detachments in eyes with inferior retinal breaks. PLoS ONE. https://doi.org/10.1371/JOURNAL.PONE.0191531

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.