Effects of SF_6 and C_3F_8 Gas Tamponade on Anterior Segment Parameters in Diabetic Patients Having Pars Plana Vitrectomy

Pars Plana Vitrektomi Uygulanan Diyabetik Hastalarda SF_6 ve C_3F_8 Gas Endo Tamponatının Ön Segment Parametreleri Üzerine Etkileri

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ABSTRACT

Purpose: To compare the effects of SF_6 and C_3F_8 gas on anterior segment biometrical parameters.

Material and Methods: Sixty patients (60 eyes) with proliferative diabetic retinopathy (PDR) having 23 gauge pars plana vitrectomy (PPV) were enrolled in this prospective study. In Group 1 (30 patients) 20% SF6 gas and in Group 2 (30 patients) 18% C3F8 gas were used as endotamponate. Anterior chamber depth (ACD), central corneal thickness, and lens thickness (LT) values were compared before and 3 months after surgery.

Results: ACD measurements significantly decreased after PPV in both groups (before / 3 months after; Group1: 3.18±0.39 mm /3.05±0.43 mm; Group 2: 3.18±0.33mm /3.11±0.36 mm) (CI 95%, p=0.001). LT was higher in Group 2 (4.32±0.33 mm) than in Group 1 (4.12±0.39 mm) at postoperative third month (CI 95%, p=0.001).

Conclusion: In PDR patients having 23 gauge PPV, in both groups, ACD measurements significantly decreased after PPV. The LT increase was higher in Group 2 than in Group 1, but further studies are needed for more information.

Key Words: Anterior chamber depth, central corneal thickness, gas endotamponate, lens thickness, pars plana vitrectomy.

ÖZ

Amaç: SF_6 ve C_3F_8 gazlarının ön segment biometrik parametreleri üzerindeki etkisini karşılaştırmak.

Gereç ve Yöntemler: Proliferatif diyabetik retinopati (PDR) tanısı ile 23 Gauge pars plana vitrektomi (PPV) uygulanan 60 hastanın (60 gözü) bu prospektif çalışmaya dahil edildi. Grup 1 (30 hasta)'de %20 SF6 gazı, Grup 2 (30 hasta)'de %18 C3F8 gazı endotamponat olarak kullanıldı. Ameliyat öncesi ve ameliyattan 3 ay sonra saptanan ön kamara derinliği (ÖKD), santral kornea kalınlığı (SKK), lens kalınlığı (LK) değerleri karşılaştırıldı.

Bulgular: PPV sonrasında her iki grupta da ÖKD ölçüm değerleri anlamlı olarak azaldı (önce / 3 ay sonra; Grup1: 3.18±0.39 mm /3.05±0.43 mm; Grup 2: 3.18±0.33mm /3.11±0.36 mm) (CI 95%, p=0.001). Ameliyat sonrası 3. ayda Grup 2 (4.32±0.33 mm) LK, Grup 1 (4.12±0.39 mm) LK değerinden anlamlı olarak yüksekti (CI 95%, p=0.001).

Sonuç: PDR'li hastalarda 23 G PPV sonrasında her iki grupta da ÖKD ölçüm değerleri anlamlı olarak azaldı. Grup 2'de, Grup 1'den daha çok LK artışı saptandı. Daha kesin sonuçlar için ileri çalışmalara ihtiyaç vardır.

Anahtar Sözcükler: Ön kamara derinliği, gaz endotamponat, santral kornea kalınlığı,lens kalınlığı, pars plana vitrektomi.

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INTRODUCTION

Cataract formation is the most common complication of pars plana vitrectomy (PPV) operations.[1] Prediction of intraocular lens (IOL) power in vitrectomized eyes can sometimes be challenging. [2-5] In vitrectomized eyes, refractive results of cataract extraction and IOL implantation have been controversial.[2-5] Prior studies also hypothesized that optical biometry is superior to ultrasonic biometry in vitrectomized eyes for better refractive results after cataract surgery. [5,6] Recently IOL power calculation formulas, like Haigis formula, use personal actual measured anterior chamber depth (ACD) rather than ACD derived from regression in the second or third-generation formulas.[6] The difference in refractive index between the vitreous body (1.3346) and aqueous humor (1.3336) were seen to produce a slightly myopic shift (–0.13 diopter) when the vitreous body was replaced by aqueous humor in vitrectomized eyes.[7] This slight change was not enough to explain the erroneous refractive results described in most studies in vitrectomized eyes.

In the literature there is not enough information about anterior segment changes following PPV with different gas endotamponades. Sulfur hexafluoride (SF_6) gas and perfluoropropane (C_3F_8) gas endotamponades have been used in pars PPV operations.[8] However, the effects of SF_6 gas and C_3F_8 gas endotamponades on anterior segment parameters after PPV have been rarely investigated.

The effects of PPV on anterior segment morphology have been detected with the use of A-scan ultrasonography, ultrasonic biomicroscopy (UBM), optical coherence tomography (OCT) and Scheimpflug imaging systems.[9-12] There are studies reporting significant differences in ACD[13] measurements and CCT[14] measurements performed with OCT, Scheimpflug camera, and ultrasonic pachymetry.[13,14] It is a fact that, resolution improves as wavelength decreases. Light has a very short wavelength compared to sound therefore laser light has better resolution. For instance in axial length measurements; the accuracy of ultrasonic biometer is approximately 0.10–0.12 mm compared to 0.012 mm for optical biometer.[15,16] It has been reported that optical biometry proved to be more accurate than ultrasounic biometry for IOL power calculation.[17]

The aim of this study is to compare the effects of SF_6 gas and C_3F_8 gas endotamponades on ACD, central corneal thickness (CCT), and lens thickness (LT) by using optical biometry after 23 gauge PPV in patients with proliferative diabetic retinopathy (PDR).

MATERIALS AND METHODS

Sixty patients (60 eyes) with PDR who had undergone 23 gauge PPV with gas endotamponade by one surgeon were included in this prospective study. This study is in accordance with the tenets of the Declaration of Helsinki. The study was performed in 2013 - 2014. In Group 1, 20% SF_6 gas was used and in Group 2, 18% C_3F_8 gas was used as endotamponade, The patients were randomly assigned to each group before the operation.

Indications for surgery were diabetic retinopathy with persistent vitreous hemorrhage, fibrovascular proliferation and tractional retinal detachment involving the macula. Patients with a history of previous ocular surgery, silicon-oil injection after PPV, intraocular lens implantation, corneal opacity, glaucoma or those using topical or systemic medication which would affect anterior segment parameters were excluded. In the study groups, no patients experienced intra-operative (such as lenticular touch) or post-operative complications (such as high IOP).

All patients had undergone a complete ophthalmic examination preoperatively. Anterior segment and crystalline lens were examined with slit-lamp biomicroscopy. The fundus was examined with a 90 Dioptry lens and OCT. Anterior segment parameters were measured with an optical biometer (LenStar LS900, Haag-Streit, Switzerland). Measurements were conducted with undilated pupils under standard conditions by a single experienced technician before examinations. After optical biometric evaluation, intraocular pressure (IOP) was measured by using noncontact tonometry (Topcon CT 80, Tokyo, Japan).

Before the PPV, pupillary dilatation was achieved by cyclopentolate hydrochloride 1% and tropicamide 1%. After retrobulbar block or subtenon anesteshia, the periorbital skin and ocular surface were cleaned with povidone-iodine. A standard 3-port 23-gauge PPV was performed with balanced salt solution (BSS plus). Anterior vitreous and vitreous base over pars plana was removed as much as possible with scleral depression. Perflorocarbon liquids were used when needed. All membranes were removed or segmented to stabilize the retina. Panretinal endo-laser photocoagulation was performed on all patients. After an air–fluid exchange, 20% SF_6 gas was injected in the patients in Group 1 and 18% C_3F_8 gas was injected in Group 2. Prophylactic subconjunctival antibiotics and steroids were administered. All patients were asked to maintain a face-down position for 1 week postoperatively. Post-operative medications were topical steroids (prednisolone 1%, 4x1) and antibiotics (moxifloxacin 0.5%, 4x1) drops for one month. Postoperative controls were performed postoperatively at day 1, week 1, month 1 and month 3.

The patients were evaluated with an optical biometer at preoperative and postoperative third month examinations. ACD, CCT and LT measurements were compared within and between the two groups.

Statistical analysis was made with SPSS (Statistical Package for Social Science) (SPSS Inc., Chicago, IL, USA) version 16.0 for Windows. Independent t-tests and paired t-tests

were used to compare the parameters. p<0.05 was accepted as statistically significant and confidence interval was taken as 95%.

RESULTS

Table 1 shows demographic data of the groups. As can be seen, there was no statistically significant difference between the two groups in terms of demographic data. **Table 1.** Table 2 shows preoperative and postoperative third month values of ACD, CCT and LT for each group. **Table 2.**

There was no statistically significant difference between the two groups for preoperative ACD, CCT and LT measurements. Although there was no statistically significant difference between the two groups for ACD and CCT at postoperative third month, a significant difference was seen between Group 1 (4,12±0,39 mm) and Group 2 (4,32±0,33 mm) in LT at postoperative third month.

For patients in both Group 1 and Group 2, there were significant decreases in postoperative third month values of ACD compared to the preoperative ACD values. There was no significant difference between the preoperative and postoperative CCT measurements in Group 1 and Group 2. There were significant increases in postoperative third month LT with respect to preoperative LT in both groups. **(Figure 1)**

No patient in either group had IOP >22 mm Hg during preoperative or postoperative third month examinations.

Table 1. *Demographic data in Group 1 and Group 2.*

	Group 1 (SF6)	**Group 2 (C3F8)**	**p**
Age (mean±SD) years	59.3±10.1	60.5±9.1	0.630
Gender (female/male)	17/13	21/9	0.292

SD: Standart deviation, p: independent t-test

DISCUSSION

There is still controversy about SF_6 and C_3F_8 gas preference as the endotamponade choice. C_3F_8 can remain in the vitreous cavity up to 8 weeks, whereas SF_6 remains up to 2 weeks. While shorter-lasting gas has a limited endotamponade effect; longer-lasting gas impairs vision longer, can limit air travel and delays return to social life, especially for patients with poor vision in the fellow eye.[18]

Marigo et al.[19], using UBM, reported no statistically significant difference between preoperative ACD and postoperative third month ACD following PPV. Park et al.[20] studied ACD with UBM before and after surgery in PDR patients.

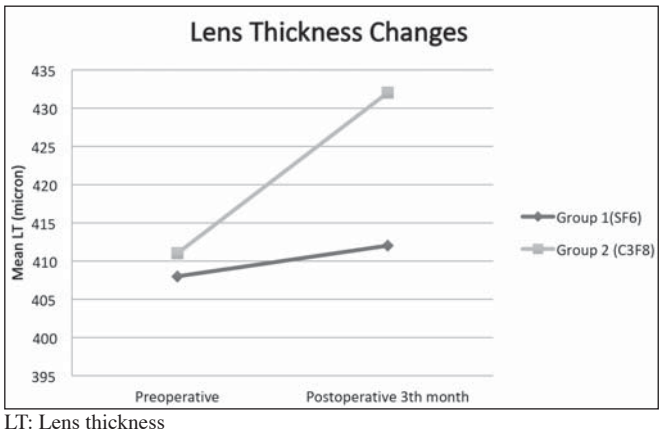
Table 2. *Anterior chamber depth, central corneal thickness, and lens thickness changes in Group 1 and Group 2.*

		Group 1 SF6	Group 2 C3F8	p* (Group1-Group2)
CCT micron	Preop	537.50±22.92 (500-575)	539.50±20.86 (510-575)	0.725
	Postop 3th month	539.67±21.69 (506-576)	541.33±22.20 (510-581)	0.770
	p (preop-postop)	0.051	0.070	
ACD mm	Preop	3.18±0.39 (2.43-3.82)	3.18±0.33 (2.68-3.72)	0.972
	Postop 3th month	3.05±0.43 (2.41-3.72)	3.11±0.36 (2.53-3.70)	0.538
	p (preop-postop)	0.013	0.001	
LT mm	Preop	4.08±0.39 (3.65-4.62)	4.11±0.40 (3.67-4.56)	0.884
	Postop 3th month	4.12±0.39 (3.68-4.64)	4.32±0.33 (3.76-4.77)	0.036
	p (preop-postop)	0.001	0.001	

p:paired t-test, p*:independent t-test

ACD: Anterior chamber depth, CCT: Central corneal thickness, LT: Lens thickness

preop:preoperative, postop:postoperative



LT: Lens thickness

Figure 1. *Lens thickness changes in Group 1 and Group 2.*

They compared phacovitrectomy with an intraocular lens group and a PPV-only group. They found decreased ACD in both groups, with a more prominent decrease in the phacovitrectomy group.[20] In the present study, also a statistically significant decrease was detected in ACD in both groups at the third month following surgery. Our result may be explained by the ease of aqueous passage from posterior segment to anterior segment. The ease of aqueous passage may be decreased by an increase in LT and the diameter of the crystalline lens. Furthermore, the removal of the anterior vitreous and vitreous base by vitrectomy may have decreased the strength of the iris-lens diaphragm in our study.

Alterations of ocular anatomy including axial lenght, keratometry and ACD by the previous PPV surgery may compromise the accuracy of sequential calculation of IOL power.[21] Watanabe and associates indicated the difference of ACD between gas and without gas tamponade was temporary, not significant 3 months after the phacovitrectomy.[22] Effective IOL position is also essential to determine the IOL power.[6] Estimation of the postoperative effective IOL position is majorly dependent on preoperative ACD measurement.[23] The anterior chamber was seen to deepen after vitrectomy in phakic eyes.[24] The ACD was further deeper after phacoemulsification in vitrectomized eyes.[5] The abnormally large ACD was probably because of zonular weakness and absence of vitreous support following vitrectomy.[25] Intravitreal long-acting gas had buoyant force to push the lens forward, reducing the ACD temporarily.[26] After the gas dissipating, the IOL position became more posterior, probably due to further weakening of the zonular elasticity.[27] In a prior study, the group undergoing phacovitrectomy with gas resulted in a deeper ACD and more hyperopic refractive outcome than those without use of gas.[3,27] The hyperopic shift might be postulated as posterior migration of IOL owing to zonular weakening caused by long-acting gas inflation, and absence of vitreous support following vitrectomy.

Çalik et al.[12] reported an increase in CCT in silicone oil–injected eyes at the postoperative first week, and a decrease in the postoperative first month were statistically significant. Increase in CCT can be related to corneal edema of more complicated surgery in silicone oil-injected eyes. Corneal edema was documented in the biomicroscopic examination in patients with increased CCT.[12] Seymen et al.[28] evaluated the CCT of patients undergoing 23-G PPV preoperatively and postoperatively at third month. They reported that CCT measurements did not change significantly during the study period.[28] In our study, there was no significant change of CCT in either group 3 months after surgery.

Previous studies showed the association between vitrectomy and progressive nuclear sclerosis and that this association increased by use of gas endotamponade.[29,30] It has been suggested that face-down positioning may prevent cataract formation in phakic patients.[31] It is believed that the longer a gas bubble is in contact with the crystalline lens, the more likely cataract progression will occur. Also, cataract progression was not prevented by shorter-acting gas.[32] There is significant increase in the oxygen level of vitreous cavity after PPV[33,34], which is associated with an increased risk of cataract formation.[35] There are reports especially for the macular hole surgery with SF_6 gas that achieved similar results with the C_3F_8 gas for visual acuity gain, macular hole closure, cumulative incidence of cataract development/extraction, and adverse events like IOP rise.[32,36] But in those studies, the effect of gases on a crystalline lens has been defined as development/extraction and measured mostly by using observational cataract grading systems. An objective sign of cataract development is an increase in LT. Recently optical biometry is in clinical use and provides us objective measurements of LT. In our study, LT was also measured with optical biometry. Regarding cataract development, Briand et al.[36] expected to obtain a lower development rate of cataracts in the SF_6 group than C_3F_8 but they found no significant difference between SF_6 and C_3F_8 groups. They explained this result by their longer follow-up period (mean 275,7 days for SF_6 and mean 238,1 days for C_3F_8), in which it was probably not the duration of the gas that created the cataract, but the vitrectomized state itself.[36] In our study, LT measurements were taken at postoperative third month, which may be effective on our results. A statistically significant increase of LT was found in both groups at the third month following surgery. The increase was higher in the C_3F_8 group. At the postoperative third month, the LT increase was higher in patients with C_3F_8 endotamponade than in patients with SF_6 endotamponade after 23 gauge PPV in patients with PDR. Our results may suggest that, 20% SF_6 may be preferred for the cases if all the indications and requirements are the same for the cases.

Limitations of the current study include its relatively small number of patients, yet there are only a few publications on this subject in the literature. As general conclusions drawn from the present study; ACD measurements significantly de-

creased after PPV in both groups, whereas the LT increase was higher in the C_3F_8 group than in the SF_6 group after 23 gauge PPV in patients with PDR. Nevertheless, further studies are needed for more information.

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