Optical Coherence Tomography Findings in Retained Subfoveal Perfluorocarbon Bubbles

Biriken Subfoveal Perflurokarbon Kabarcıklarının Optik Kohorens Tomografi Bulguları

Mehmet Yasin TEKE[1], Ufuk ELGİN[2], Pınar YÜKSEKKAYA[1], Nilüfer BERKER[2], Pınar ÖZDAL[2], Emine ŞEN[1], Faruk ÖZTÜRK[3]

ABSTRACT

Our aim in this case series was to report and discuss the clinical and optical coherence tomography (OCT) findings of six eyes of six cases with retained subfoveal perfluorocarbon (PFC) bubbles after vitreoretinal surgery. The six cases were referred to the retina department of our hospital for decreased visual acuity related to rhegmatogenous retinal detachment and underwent vitreoretinal surgery with PFC. In addition to the ophthalmological examinations, OCT in all and fundus autofluorescence (FAF) findings in some cases were also evaluated in the postoperative period. Retained subfoveal PFC bubbles were detected clinically in all eyes. OCT showed hyporeflective, homogenous round bubbles while FAF showed hypofluorescent bubbles with a hyperfluorescent surrounding area. It was concluded that OCT and fundus autofluorescence could support clinical observations for the diagnosis of retained subfoveal PFC bubbles that may cause retinal pigment epithelium (RPE) atrophy.

Key Words: Perfluorocarbon, rhegmatogenous retinal detachment, vitreoretinal surgery, optical coherence tomography, fundus autofluorescence.

ÖZ

Bu vaka serisinde, vitreoretinal cerrahi sonrasında subfoveal perflorokarbon saptanan altı vakanın, klinik ve optik kohorens tomografi (OKT) bulgularını sunmayı amaçladık. Görme azlığı şikayeti ile Retina birimine başvuran hastalarda regmatojen retina dekolmanı saptandı. Tüm olgulara, perflorokarbon kullanılarak vitreoretinal cerrahi uygulandı. Cerrahi sonrası dönemde tüm olgulara, oftalmik muayeneye ilaveten OKT, bazı olgulara ise fundus otofloresans (FAF) görüntülemeleri yapıldı. Cerrahi sonrasında olguların hepsinde, subfoveal perflorokarbon klinik olarak tespit edildi. Aynı zamanda OKT ile hiporeflektif uniform, yuvarlak kabarcıklar, FAF ile ise kendisi hipo, etrafı hiperotofloresans kabarcıklar izlendi. Sonuç olarak, OKT ve fundus otofloresans, retina pigment epiteli atrofisine yol açabilen subfoveal perflorokarbon teşhisinde klinik incelemelere yardımcı yöntemlerdir.

Anahtar Kelimeler: Perflorokarbon, regmatojen retina dekolmanı, vitreoretinal cerrahi, optik koherens tomografi, fundus otofloresans.

1- M.D. Ulucanlar Eye Training and Research Hospital, Ankara/TURKEY
TEKE M.Y., mehteke@gmail.com
YUKSEKKAYA P., drpnarnalca@yahoo.com
SEN E., eminesentr@yahoo.com
2- M.D. Associate Professor, Ulucanlar Eye Training and Research Hospital, Ankara/TURKEY
ELGIN U., ufukelgin@superonline.com
BERKER N., nilüferberker@gmail.com
OZDAL P., pinarozdal@hotmail.com
3- M.D. Professor, Ulucanlar Eye Training and Research Hospital, Ankara/TURKEY
OZTURK F., drfaruk2@yahoo.com

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Yazışma Adresi / Correspondence Adress: M.D. Associate Professor, Ufuk ELGİN
24 Sokak, No:13/4 06490, Bahcelievler, Ankara /TURKEY

Phone: +90 532 432 09 69
E-Mail: ufukelgin@superonline.com

INTRODUCTION

Perfluorocarbons (PFCs) are compounds made of carbon and fluorine and are usually liquid at room temperature.[1-4] They are routinely used in the treatment of rhegmatogenous retinal detachment (RD), giant retinal tears, proliferative vitreoretinopathy and some other conditions. Low viscosity, optical clearance, density (more dense than water) and solubility (they cannot dissolve in and mix with water) are the main physical characteristics that make them easy to use. PFCs facilitate surgical procedures by stabilization of the retina.[3] Their main intraoperative complications are retained vitreal or subretinal PFC bubbles due to the absence of saline solution irrigation after PFC-gas exchange in giant retinal tears and wide retinotomies. Retained subretinal PFC bubbles are a rare but vision-threatening and retinotoxic complication of vitreoretinal surgery (VRS).[5-6] We report our clinical observations in addition to optical coherence tomography (OCT) findings using spectral-domain OCT (Spectralis, Heidelberg Engineering, Germany) in the six eyes of six cases with retained subretinal perfluorodecalin (decasol, Ak Akın Medical Industry, Istanbul) bubbles after VRS. We also present the results of fundus autofluorescence photography (FAF) with the Heidelberg Retina Angiograph (HRA 2, Spectralis, Heidelberg Engineering, Germany) in some cases.

CASE REPORT

All cases were hospitalized for RD and underwent pars plana vitrectomy (PPV) with perfluorodecalin and endolaser photocoagulation followed by perfluorodecalin-gas exchange and extraction of retained vitreal PFC bubbles by intravitreal saline irrigation and finally intravitreal tamponade for the retinal tear.

Case 1

RD and vitreous hemorrhage (VH) were detected in the left eye of a 62-year-old female who had uncomplicated cataract surgery 2 years ago in the same eye. The visual acuity (VA) was 8/10 (Snellen chart) in the right eye and counting fingers at 1 meter in the affected eye. Fundoscopy revealed a retinal tear involving two clock hours of the retina (between 12 and 2 o'clock) and RD in the inferior quadrant of retina.

She underwent surgery with sulfur hexafluoride (SF_6) tamponade for the retinal tear. At the second postoperative week, the VA was counting fingers at 4 meters. Fundoscopy revealed two separate subretinal retained PFC bubbles in the macular area that were almost 1/2 and 1/4 optic disc diameter respectively in size (Figure 1a). OCT showed oval hyporeflective bubbles with uniform boundaries indicating subretinal bubbles (Figure 1b).

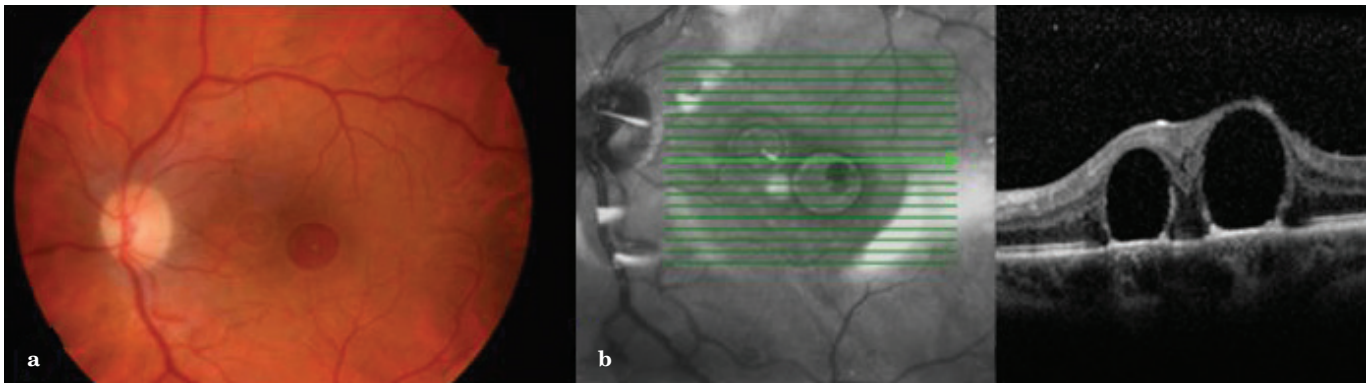

Figure 1a,b: *Color fundus photography of the left eye shows two separate PFC bubbles almost 1/2 and 1/4 optic disc diameter in size respectively (a), OCT shows oval hyporeflective subretinal bubbles with uniform borders in the macular area (b).*

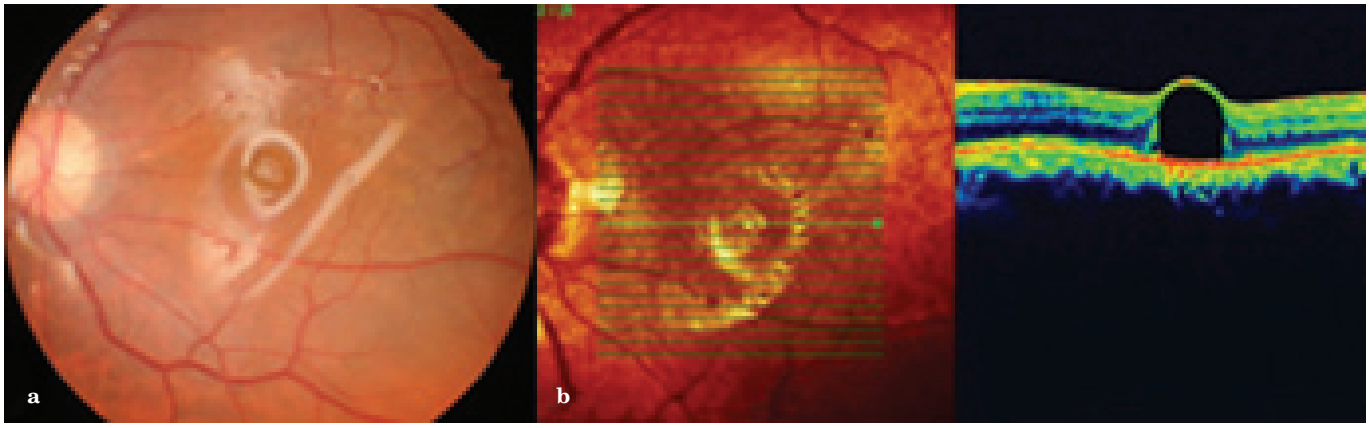

Figure 2a,b: *Color fundus photography of the left eye shows brightness related to SO and a subretinal retained PFC bubble almost 1/5 optic disc diameter in size (a), OCT shows oval hyporeflective subretinal bubbles with uniform borders (b).*

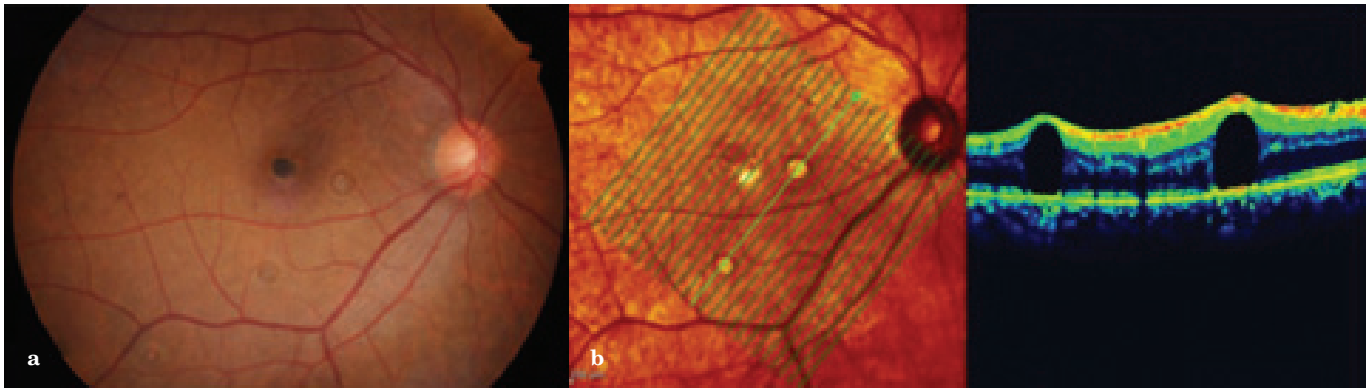

Figure 3a,b: *Color fundus photography of the right eye shows three separate subretinal retained PFC bubbles with retinal pigment epithelium changes in the macula (a), OCT shows oval hyporeflective subretinal bubbles with uniform borders (b).*

Case 2

A 59-year-old male was hospitalized for RD in his left eye. The VA was 10/10 in the right eye and counting fingers at 2 meters in the left eye. Fundoscopy revealed a total RD in the left eye. During surgery, a retinal tear with flap was detected between 9 and 11 o'clock. 15% perfluoropropane (C_3F_8) was injected at the end of surgery. The VA was counting fingers at 1 meter on the first postoperative day, 1/10 on the second postoperative month and 4/10 at the fourth postoperative month. At the sixth postoperative month, he was referred again for decreased VA in the same eye and a new retinal tear near the original one was detected together with RD. After reattachment of the retina by perfluorodecalin, endolaser around the retinal tear, PFC-gas exchange and extraction of retained bubbles by intravitreal saline irrigation were performed. Finally 1000 cs silicone oil (SO) was injected intravitreally for tamponade. The VA was counting fingers at 3 meters at the third postoperative month. Fundoscopy revealed brightness related to SO and a subretinal retained PFC bubble almost 1/5 optic disc diameter in size (Figure 2a). OCT showed oval hyporeflective subretinal bubbles with uniform boundaries (Figure 2b).

Case 3

A 55-year-old male was hospitalized for RD in his right eye. The VA was 7/10 in the left eye and counting fingers at 2 meters in the right eye. Slit-lamp examination showed mild cataract formation and fundoscopy revealed a total RD in the right eye with 5 peripheral retinal tears within five clock hours of the retina (between 9 and 2 o'clock).

Combined phacoemulsification and in-the-bag intraocular lens (IOL) implantation and PPV procedures were performed for the patient and 15% perfluoropropane (C_3F_8) was injected at the end of surgery.

The VA was hand motion at 1 meter on the first postoperative day and 3/10 at the second postoperative month. Fundoscopy revealed three separate subretinal retained PFC bubbles with retinal pigment epithelium (RPE) changes in the macula (Figure 3a). OCT showed round hyporeflective subretinal bubbles with uniform boundaries (Figure 3b).

Case 4

A 72-year-old male was hospitalized for RD in the right eye. He had undergone an uncomplicated cataract surgery in his right eye 6 months ago. The visual acuity (VA) was 3/10 in the left and counting fingers at 2 meters in the right eye. Slit-lamp examination showed cataract formation in the left eye.

Fundoscopy revealed two retinal tears at 2 and 5 o'clock and RD in the inferior quadrant of the retina. After the surgical procedure, 1000 cs SO was injected intravitreally to tamponade the retinal tears.

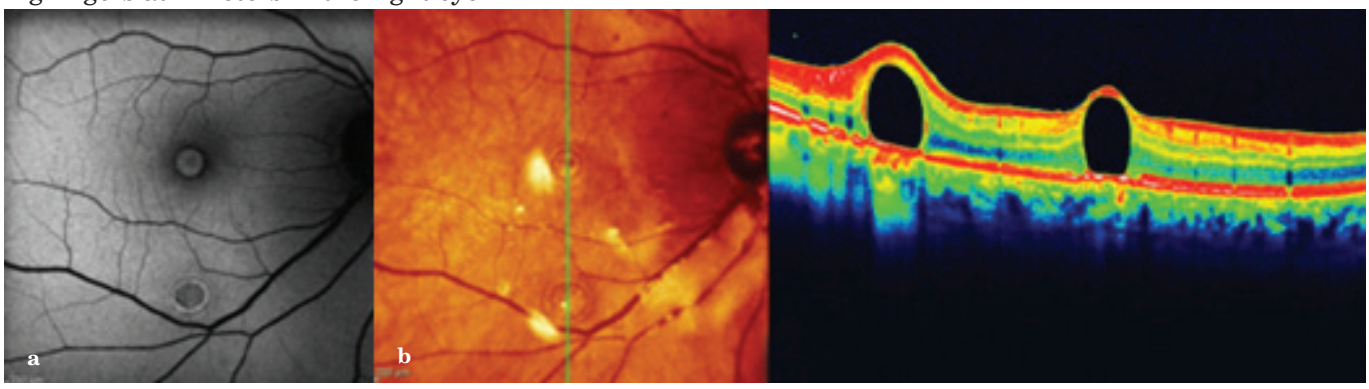

Figure 4a,b: *Fundus autofluorescence photography of the right eye reveals that the PFC bubbles was hypoautofluorescent while the surrounding area was hyperautofluorescent (a), OCT shows two oval hyporeflective subretinal bubbles with uniform borders (b).*

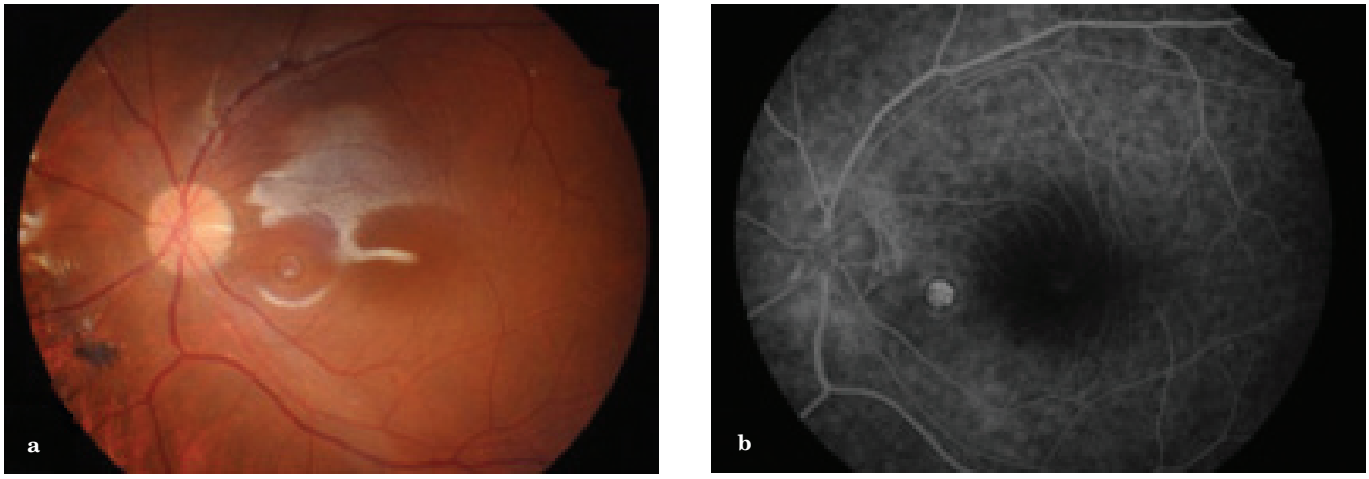

Figure 5a,b: *Color fundus photography of the left eye shows a retained PFC bubble under the silicone reflex at the papillomacular region (a), Fluorescein angiography of the left eye showed hyperfluorescence due to the window defect related to the RPE atrophy caused by the PFC fluid (b).*

The VA was hand motion vision at 1 meter on the first postoperative day and counting fingers at 3 meters on the second postoperative week. Fundoscopy revealed brightness related to SO and two retained PFC bubbles at the subfoveal region and just under the fovea almost 1/5 optic disc diameter in size (Figure 3). Right eye FAF showed the central PFC droplet to be hyperautofluorescent. This was due to the increased light with 480 nm wavelength reaching the lipofuscin in the RPE as a result of the pushing aside of foveal pigments by the PFC drop as in cystoid macular edema, and the thinning of the sensorial retina, as can be seen in the OCT section. The PFC droplet below was hypoautofluorescent while the surrounding area was hyperautofluorescent (Figure 4a). The vertical OCT section showed two oval hyporeflective bubbles with uniform boundaries (Figure 4b)

Case 5

A 55-year-old male was hospitalized for RD in the left eye. He had undergone uncomplicated cataract surgery two years ago in his left eye. The visual acuity (VA) was 9/10 in the right and counting fingers at 1 meter in the left eye.

Slit-lamp examination showed a posterior chamber IOL. Fundoscopy revealed a horseshoe retinal tear at 11 o'clock and RD in the inferior quadrant of retina.

After the surgical procedure 1000 cs SO was injected intravitreally to tamponade the retinal tear. The VA was counting fingers at 3 meters on the first postoperative day and fundoscopy revealed brightness related to SO. He was unable to come for follow-up visits for 6 months because of his systemic problems.

At the sixth postoperative month, the VA was counting fingers at 5 meters and a retained PFC bubble at the papillomacular region was detected under the silicone reflex (Figure 5a). FA showed hyperfluorescence due to the window defect related to the RPE atrophy caused by the PFC fluid (Figure 5b).

The FAF image reveals hypoautofluorescence in the RPE atrophy area (decreased lipofuscin) while the surrounding area was hyperautofluorescent (Figure 6a).

Grayscale images of the horizontal OCT section showed oval subretinal bubbles and a silicone reflex (Figure 6b).

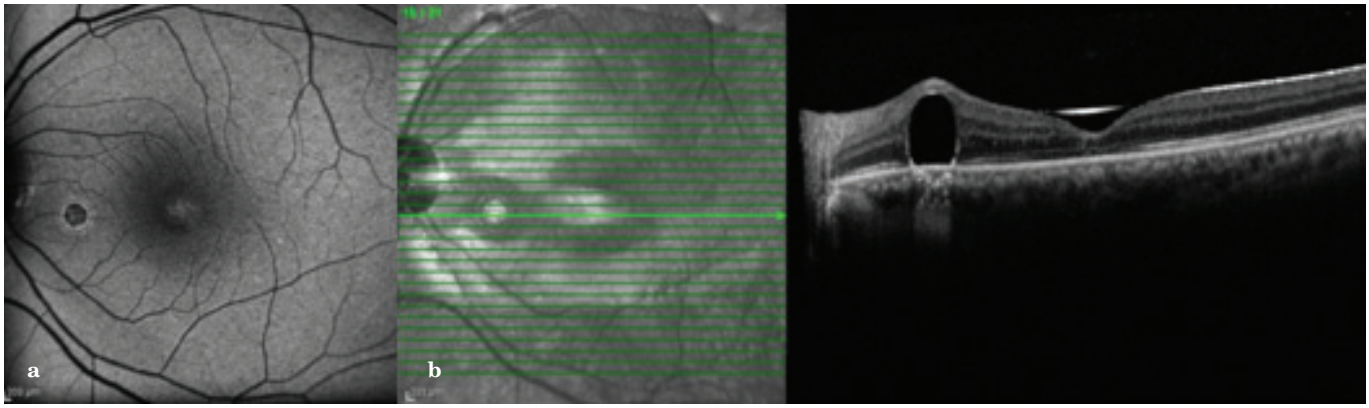

Figure 6a,b: *Fundus autofluorescence photography of the left eye reveals hypoautofluorescence in the RPE atrophy area (decreased lipofuscin) while the surrounding area is hyperautofluorescent (a), Grayscale images of OCT show oval subretinal bubbles and silicone reflex (b).*

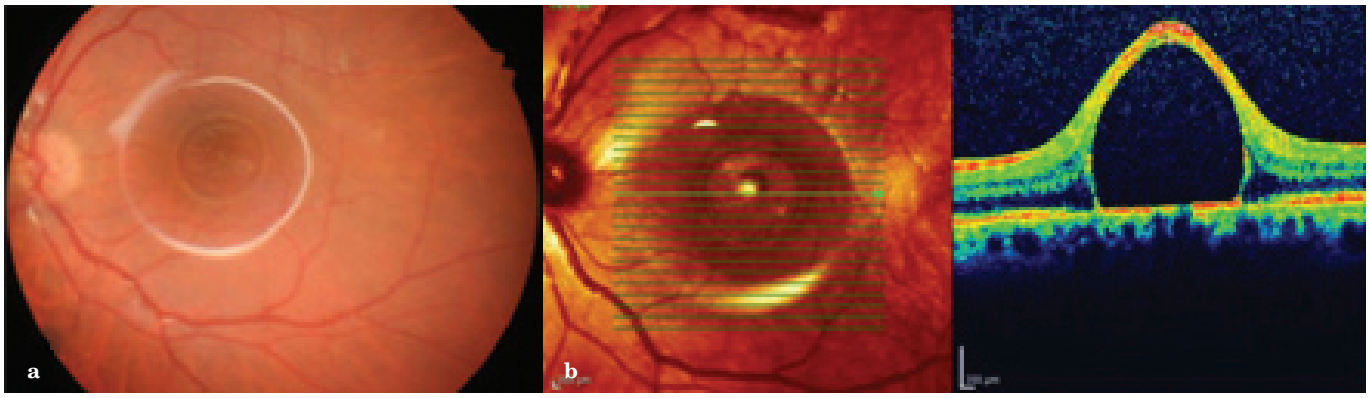

Figure 7a,b: *Color fundus photography of the left eye shows a retained subretinal PFC bubble wider than one disc diameter at the papillomacular region (a), OCT shows a hyporeflective bubble with a relatively wide base and narrow top (b).*

Case 6

A 65-year-old male was hospitalized for RD in his left eye. The VA was 10/10 in the right eye and counting fingers at 5 meters in the left eye. Fundoscopy revealed RD in the inferior quadrant of the retina with a peripheral retinal tear at 3 o'clock.

After the surgical procedure 1000 cs SO was injected intravitreally to tamponade the retinal tear. The VA was counting fingers at 4 meters on the first postoperative day. After one week, the VA was counting fingers at 4 meters and fundus examination revealed brightness related to SO and a retained subretinal PFC bubble wider than one disc diameter at the papillomacular region (Figure 7a). The horizontal OCT section showed a hyporeflective bubble with a relatively wide base and narrow top (Figure 7a).

DISCUSSION

PFCs can facilitate all steps of VRS and can affect the outcome of the surgery thanks to their characteristics of low viscosity, optical clearance, insolubility in water and higher density than water. They are used as temporary tamponade and must be extracted totally at the end of the surgery.[3-4,6-8] Retained subretinal or vitreal PFC bubbles are the main complication with an incidence of 0.9% and various views are present on the effects of long-term retained PFC on retinal function.[7] The reasons for retained PFC bubbles are especially retinotomies wider than 120° and incomplete extraction due to insufficient intravitreal irrigation with saline. This is not unusual for wide retinotomies because of the wide entrance to the subretinal space. A peripheral small retinotomy and retinal tears at a posterior location are not risk factors for retained PFCs.[6] Irrigation of the vitreous after PFC-gas exchange is an important procedure for the prevention of this complication that can result in the accumulation of small, undetectable microscopic bubbles on the retina after the extraction of macroscopic bubbles.[6] Winter et al.[9] reported an important decrease in the incidence of this complication after intravitreal irrigation in their experimental study. The incidence of retained PFC bubbles decreased from 0.51-0.69% without irrigation to 0.11-0.27% with irrigation. On the other hand, intravitreal irrigation may cause more contact of PFC with air and increased evaporation.[9] Without irrigation, the retained intravitreal PFC can enter the subretinal space through the unclosed retinal tear due to head position.

SO tamponade can increase the rate of this complication by elevating the edge of the retinal tear within the early postoperative period because of its low floating effect and the retained PFC bubbles at the edge of the tear.[6] We observed 2 bubbles in the first and 3 bubbles in the third case, despite the lack of a giant tear, wide retinotomy or SO use in either case. Insufficient irrigation was thought to be the reason for this complication in these cases. We used SO in our second, fourth, fifth and sixth cases and that may be the cause of the retained bubbles.

One of our aims in this study was to report the OCT findings of our cases in addition to the clinical findings. Joondeph et al.[10] reported a case of submacular retained PFC in their study where they observed cystic spaces in the central macula in the subretinal space by time-domain OCT. They emphasized that OCT was important especially for the differential diagnosis of retained subretinal PFC and residual subretinal fluid and indicated that retained PFC produced distinctive bubbles beneath the retina while subretinal fluid produced a dome-shaped elevation of the retina.[10]

Soheilian et al.[11] reported the three-dimensional OCT features of their two cases with retained submacular PFC and provided more detailed findings about retained PFC-related disruptions. They showed damaged RPE, and disruption of both the external limiting membrane backreflection line and the reflectivity of the photoreceptor inner and outer segment junction.

Subretinal PFC in the extramacular region may not affect the VA but a subfoveal retained bubble may cause even total blindness. Such bubbles must be extracted because of their toxic effects on the retina and the risk of macular hole but the VA may also decrease because of the surgery.[4,12-13] The decreased VA in our first case may be related to PFC bubbles as OCT showed severe impairment of foveal anatomy despite the attached retina. The retained bubbles should be extracted immediately in such cases. Clinical and OCT findings in our second and fourth cases also indicate the PFC bubbles as the main reason of decreased VA, in addition to changes in the refractive status of the eyes due to SO. In contrast, the decreased VA of the third case was thought to be related to foveal changes despite the extrafoveal location the bubbles. The FA of our fifth case showed hyperfluorescence due to the window defect related to RPE atrophy that was thought to be caused by the 6-month delay in the removal of the retained PFC bubble, demonstrating the importance of immediate surgical removal of PFC.

SO was used for retinal tamponade in three of our cases and retained subretinal PFC bubbles were detected in these eyes. Subretinal SO and PFC can easily be differentiated both clinically and by OCT imaging because of their differences in viscosity, density and surface tension.[14] In contrast to PFC bubbles with distinct borders, subretinal SO spreads and forms a shallow elevation in a wide area. In our cases with siliconized eyes, the retained bubbles should have had the same appearance as the SO in the vitreous if they had been retained SO but they actually looked like quite different. SO causes a retinal image shift In OCT imaging as it is more intense than vitreous but this was not present in our cases. There is of course a margin of error and a chemical examination would be necessary for their exact differentiation.

The central PFC bubble was seen to be hyperautofluorescent in the fourth case. This is due to the increased light with 480 nm wavelength reaching the RPE as a result of the pushing aside of foveal pigments by the bubble as in cystoid macular edema, and thinning of the sensorial retina as can be seen in the OCT section. The PFC bubble below was hypoautofluorescent while the surrounding area was hyperautofluorescent. The fifth case showed hypoautofluorescence on FAF due to the RPE atrophy (decreased lipofuscin) caused by the PFC bubble. The different FAF signs in these two patients are related to the location and duration of the PFC bubbles and this had not been reported previously as far as we know.

PFCs are temporary tamponades that can directly affect the course and outcome of VRS. Total extraction of PFCs by recurrent intravitreal irrigation is very important because of their toxic effects on the retina. OCT shows hyporeflective bubbles with uniform borders and can help the clinicians in the diagnosis of these bubbles. FAF is also an important imaging technique for the diagnosis as it reveals hyper- or hypoautofluorescence due to these bubbles, RPE atrophy, or shadowing of the underlying tissues. Further investigations for the usage of FAF in retained PFCs should be encouraged.

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