

Original Article

Long-term complications of surgical procedures for pseudophakic retinal detachment

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Abstract: Purpose: This study aimed to evaluate and compare the long-term surgical complications of scleral buckling (SB), pars plana vitrectomy (PPV), and their combination in pseudophakic retinal detachment (PRD). Methods: This retrospective study included 127 patients who were operated with PRD diagnosis and followed-up for at least 6 months. The patients were divided into 4 groups: Group 1 included cases undergoing SB surgery (n=31), Group 2 included cases undergoing PPV with perfluoropropane (C3F8) gas (PPV+Gas) (n=36), Group 3 included cases undergoing PPV with silicone oil (PPV+Silicone) (n=40), and Group 4 included cases undergoing PPV together with SB (SB+PPV) (n=20). The long-term postoperative complications including epiretinal membrane (ERM), cystoid macular edema (CME), persistent intraocular pressure (IOP) elevation, proliferative vitreoretinopathy (PVR), anisometropia, extraocular muscle (EOM) dysfunction/diplopia, and macular hole were assessed and compared. Results: The mean follow-up duration of the study population was 34.8 ± 17.9 months. No significant differences were noted among the groups regarding the frequency of ERM, CME, persistent IOP elevation, and PVR ($P > 0.05$). The frequency of anisometropia was significantly higher in the SB and SB+PPV groups than in the other groups ($P < 0.001$). EOM dysfunction was observed only in 2 (6.5%) patients in the SB group. Conclusions: The frequencies of many long-term surgical complications following SB, PPV (gas or silicone oil) or combined surgical procedures were similar. SB unfavorably influences functional vision since it is associated with increased risk of anisometropia and EOM dysfunction. Therefore, potential risk of development of such complications should be considered while preferring SB or combined procedure.

Keywords: Late surgical complications, pars plana vitrectomy, pseudophakic retinal detachment, scleral buckling

Introduction

It is known that approximately 40% of the cases with retinal detachment are pseudophakic [1]. Nowadays, scleral buckling (SB) and pars plana vitrectomy (PPV), either separately or in combination, are the most commonly performed surgical techniques in the treatment of pseudophakic retinal detachment (PRD). Although pneumatic retinopexy is performed in the treatment of rhegmatogenous retinal detachment (RRD), it is not mostly preferred in the treatment of PRD [2-4]. The follow-up of cases undergoing surgery for RRD includes monitoring the results of surgical procedure and the related pathological events. Complications after retinal detachment surgery may have unfavorable effects particularly on visual acuity. These complications occur due to the pri-

mary disease itself, surgical procedure, and the tamponade [5].

The present study aimed to investigate the relation of postoperative complications such as epiretinal membrane (ERM, also called macular pucker), cystoid macular edema (CME), intraocular pressure (IOP) elevation, proliferative vitreoretinopathy (PVR), anisometropia, extraocular muscle (EOM) dysfunction/diplopia, and macular hole (MH), which occur in the long-term following retinal detachment surgery and unfavorably affect functional and anatomical success, with various surgical techniques.

Patients and methods

Medical files of patients who were operated for PRD between January 2005 and October 2015

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were retrospectively reviewed. Patients aged over 18 years with a follow-up duration of at least 6 months were included. Patients with a history of ocular trauma, diabetic retinopathy, glaucoma, uveitis, MH, wet form of age-related macular degeneration, macular geographic atrophy, choroid neovascular membrane, or macular scar were excluded. Within this context, the present study comprised the patients with PRD. Patients with giant retinal breaks (retinal break equal to or greater than 3 clock hours), those having PVR higher than grade C, those with vitreous hemorrhage, and those with vitreous opacity obscuring fundus view were also excluded. On the slit lamp examination performed prior to the surgery, the intraocular lens was located in the posterior chamber in all PRD patients included in the present study. Accordingly, 127 eyes of 127 patients were included. The present study was approved by the Ethics Committee of Ankara Numune Training and Research Hospital and conducted in accordance with the 1995 Helsinki Declaration. Informed consent was obtained from all individual participants included in the study. All patients were Turkish Caucasians.

In addition to age, gender, and demographic characteristics of the patients, data regarding postoperative follow-up, duration of follow-up period, and type of surgical procedure were obtained from the medical files of the patients. The following findings that were obtained during the pre- and post-operative follow-ups were recorded: the best corrected visual acuity (BCVA) measured by the Snellen Chart, autorefractometry findings, intraocular pressure measured by Goldmann applanation tonometry, the anterior segment findings by the slit-lamp examination, findings of the dilated fundus examination performed using a +90 diopter (D) lens, an indirect ophthalmoscope, and a Goldmann three-mirror lens, and spectral domain optical coherence tomography (OCT) findings.

The patients were divided into 4 groups according to the surgical procedure. Group 1 included cases undergoing SB surgery (n=31), Group 2 included cases undergoing PPV with perfluoropropane (C3F8) gas (PPV+Gas) (n=36), Group 3 included cases undergoing PPV with silicone oil (PPV+Silicone) (n=40), and Group 4 included cases undergoing PPV together with SB (SB+PPV) group (n=20).

All patients were evaluated at the postoperative 1st day and at the postoperative 1st, 3rd, and 6th months; the follow-up visits of the patients whose visits continued after 6 months of surgery were also evaluated. The last examination of each patient was considered as the last follow-up visit of that patient. BCVA, IOP, relapse status on fundus examination, and complications were evaluated during the last visits. Elevation in IOP was defined as an IOP over 22 mmHg and/or as commencement of treatment with antiglaucomatous drugs. Anisometropia was defined as a change in the spherical equivalent refraction by ≥ 2.00 D in the operated eye.

Surgical procedure

The surgeries were performed under local peribulbar and retrobulbar anesthesia (2% lidocaine and 0.5% bupivacaine) by two experienced surgeons (MC, MYT) in all eyes. While one of the surgeons (MC) performed only SB, the other surgeon (MYT) performed both PPV (PPV+Gas or PPV+Silicone) and combined surgery.

In the SB group (n=31), the surgical procedure consisted of 360° encircling (using a 2.5-mm silicone band), subretinal fluid drainage, and cryotherapy steps following the detection of retinal breaks by an indirect ophthalmoscope (with 20 D lens) after the fixation sutures were passed through 4 rectus muscles. In addition, intravitreal air injection was performed in all patients undergoing SB. Buckling material was sutured to the sclera using 5-0 polyester.

In the PPV groups, a standard three-port transconjunctival sutureless PPV was performed using a one-step system including a pneumatic vitreous cutter (D.O.R.C, Associate, the Netherlands). Visualization during vitrectomy was achieved with a non-contact wide-angle system (Erect Indirect Binocular Ophthalmoscopic System; Möller-Wedel, Wedel, Germany). After displacing the conjunctiva, using a 23-gauge cannula system with a microvitrectomy blade trocar, incisions were made with an incision angle of 30° through conjunctiva, sclera, and pars plana 3.0-3.5 mm from the corneoscleral limbus in order to obtain tunnels parallel to the corneoscleral limbus. A complete vitrectomy, which included the removal of the anterior vitreous gel with scleral indentation, was performed.

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Table 1. Descriptive characteristics and follow-up duration among the study groups

	Groups				P*
	SB (n=31)	PPV+Gas (n=36)	PPV+Silicone (n=40)	SB+PPV (n=20)	
Age (year)	60.13 ± 11.52	60.33 ± 10.14	59.88 ± 10.85	57.30 ± 16.21	0.950
Gender					
Male	24 (77.4)	22 (61.1)	33 (82.5)	18 (90.0)	0.056
Female	7 (22.6)	14 (38.9)	7 (17.5)	2 (10.0)	
Follow-up duration (month)	37.84 ± 15.37	32.19 ± 11.88	34.45 ± 24.09	36.00 ± 16.92	0.343

SB, scleral buckling; PPV, pars plana vitrectomy. Data are presented as mean ± standard deviation or number (%), where appropriate. *Kruskal-Wallis test for numerical variables, chi-square test for categorical variables.

A wide-angle viewing system was used for searching for retinal breaks in the periphery and central retina. Following internal subretinal fluid drainage, retinal re-attachment was achieved by decalin (perfluorocarbon liquid, perfluoro-n-octane, C₈F₁₈) and 360° endolaser photocoagulation was performed around the break and the peripheral retina. Together with decalin air exchange, perfluoropropane (C₃F₈) was used in the PPV+Gas group (n=36) and silicone oil was in the PPV+Silicone group (n=40) as vitreous tamponades. The tamponade was chosen based on the surgeon's discretion. Silicone oil was preferred for the patients who were not able to maintain the prone position and for those who must travel by air. Moreover, combined surgery (SB+PPV) was performed only in the cases with PVR grade C. In the SB+PPV group (n=20), encircling band was placed as was described above and subsequently PPV was performed. Perfluoropropane was used as the tamponade in all patients of the SB+PPV group.

Perfluoropropane gas (C3F8, GOT C3F8 multi, Alchimia) gas was diluted at a rate of 16% before use. The silicone oil used in the study was 5000 cSt (centistokes) silicone oil (PDMS® Micromed, Rome, Italy). Silicone oil stayed in the eye for 3 months in the PPV+Silicone group.

Patients that developed retinal redetachment in all groups underwent PPV and intraoperative endolaser treatment; and if needed, epiretinal-subretinal membrane peeling, endodiathermy or retinotomy was performed and silicone oil was used as a tamponade. The data related with the postoperative complications were assessed after the removal of silicone.

Statistical analysis

Data were analyzed by the Predictive Analytics Software version 22.0 (IBM Corp., Armonk, NY,

USA). Descriptive statistics were expressed as mean, standard deviation, frequency distribution, and percentage. In addition to descriptive statistics, Pearson chi-square test was used. The Kruskal-Wallis test was used to compare three independent groups. In case of a significant difference, post-hoc test with Bonferroni correction was performed to identify the difference. A P value < 0.05 was considered statistically significant.

Results

In the present study, 127 patients with a mean age of 59.66 ± 11.72 years were examined in 4 groups. Of the patients, 97 (76.4%) were male and 30 (23.6%) were female. The mean follow-up duration was 34.8 ± 17.9 months. Retinal detachment surgery was performed in the right eye in 74 (58.3%) patients and in the left eye in 53 (41.7%) patients. The descriptive characteristics and follow-up duration among the study groups are presented in **Table 1**.

No significant differences were determined among the study groups in terms of age, gender, and follow-up duration (P=0.950, P=0.056, P=0.343 respectively). On the final follow-up visit, it was observed that the retina was anatomically re-attached in all patients. The mean number of surgeries to provide retinal re-attachment was 1.28 ± 0.54 in all patients. There were no significant differences among the study groups in terms of anatomical success and the mean number of surgeries performed (P=0.705 and P=0.508, respectively; **Table 2**).

The long-term post-operative complications encountered in the study groups are presented in **Table 3**. A significant difference was determined among the study groups in terms of the rate of anisometropia (P<0.001). The frequency of anisometropia was significantly higher in the

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Table 2. Mean number of surgeries performed and anatomical success in the study groups

	SB (n=31)	PPV+Gas (n=36)	PPV+Silicone (n=40)	SB+PPV (n=20)	P
Anatomical success achieved in					
Single surgery	21 (67.7)	30 (83.3)	31 (77.5)	16 (80.0)	
Two surgeries	8 (25.8)	4 (11.1)	7 (17.5)	4 (20.0)	0.705
Three surgeries	2 (6.5)	2 (5.6)	2 (5.0)	0	
Number of surgeries	1.39±0.62	1.22±0.54	1.28±0.55	1.20±0.41	0.508

SB, scleral buckling; PPV, pars plana vitrectomy. Data are presented as mean±standard deviation or number (%), where appropriate. Chi-square test for categorical variables, Kruskal-Wallis test for numerical variables.

Table 3. Distribution of the long-term postoperative complications among the study groups

	SB - (n=31) n (%)	PPV+Gas (n=36) n (%)	PPV+Silicone (n=40) n (%)	SB+PPV (n=20) n (%)	P*
ERM	8 (25.8)	8 (22.2)	9 (22.5)	4 (20.0)	0.968
CME	2 (6.5)	4 (11.1)	10 (25.0)	2 (10.0)	0.115
IOP elevation	5 (16.1)	1 (2.8)	7 (17.5)	4 (20.0)	0.169
PVR	5 (16.1)	5 (13.9)	6 (15.0)	4 (20.0)	0.943
Anisometropia	9 (29.0)	0	0	6 (30.0)	<0.001
EOM dysfunction	2 (6.5)	0	0	0	0.098
Macular hole	1 (3.2)	0	1 (2.5)	0	0.645

*Chi-square test. SB, scleral buckling; PPV, pars plana vitrectomy; ERM, epiretinal membrane; CME, cystoid macular edema; PVR, proliferative vitreoretinopathy; EOM, extraocular muscle.

SB and SB+PPV groups than in the other groups (Table 3). No significant differences were determined among the study groups in terms of the rates of ERM, CME, glaucoma, PVR, restricted eye movement, and MH ($P>0.05$; Table 3). The patients having substantially reduced BCVA or metamorphopsia due to ERM underwent PPV. In 7 patients fulfilling these criteria (4 in the PPV+Silicone group, 2 in the PPV+Gas group, and 1 in the SB group), ERMs were removed surgically by a 23-gauge transconjunctival sutureless PPV. Trabeculectomy was performed in 1 patient in the SB group in whom IOP elevation could not be controlled with medical therapy.

Discussion

The present study investigated the common long-term complications following various surgical techniques including conventional SB, PPV (either using perfluoropropane gas or silicone oil as intravitreal tamponade), or SB together with PPV which were performed for PRD repair.

Development of ERM is one of the undesired complications following a successful surgery. ERM may be asymptomatic or may lead to a

decrease in visual acuity or metamorphopsia. While some previous studies have reported the risk factors for ERM as macular involvement, vitreous hemorrhage, folding of the edge of the break, star fold, and multiple surgical interventions [6], there are studies suggesting that ERM development is associated with the size of

retinal break, equatorial localization, and a long duration of macular detachment but not with macular detachment [7]. In large series, the frequency of ERM following primary RRD repair by SB have been reported to range between 3% and 8.5% [8-11]. In their prospective study, Ahmadieh et al [12] reported the frequency of ERM was 22.2% in both SB and PPV groups at the postoperative 6th month in pseudophakic and phakic patients undergoing retinal detachment surgery, with no significant difference between the groups. In another prospective study, ERM development was reported after PPV in 28 (8.97%) of 312 eyes with pseudophakic or phakic RRD during a 12-month follow-up period and no significant difference was determined between the groups undergoing PPV either with silicone oil or gas tamponade regarding the frequency of ERM [7]. In the present study, the rate of long-term post-operative ERM was higher as compared to those reported in the literature. The rates of ERM in the SB, PPV+Gas, PPV+Silicone, and SB+PPV groups were 25.8%, 22.2%, 22.5%, and 20%, respectively. No significant difference was determined among the groups in terms of the rate of post-operative ERM ($P<0.05$).

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Another frequent complication following retinal surgery is CME. Drainage, cryotherapy, diathermy, and scleral compression that are performed intraoperatively are inflammatory causes. Impaired choroidal circulation following SB is also a cause of macular edema [13-15]. The rates of CME following retinal detachment repair by SB in phakic or pseudophakic eyes ranges between 5.6% and 40% [14, 16-18]. The rates of CME following vitrectomy surgery for retinal detachment have been reported between 1.4% and 17% in some previous studies [7, 15, 19-21]. In the study by Schaal et al [22] primary retinal detachment repair was performed using different surgical techniques; according to the 1-year outcomes, a significant increase in the rate of postoperative CME was reported in the patients undergoing SB with or without vitrectomy (16% for SB, 29% for SB+PPV) as compared to those undergoing PPV alone (4% for PPV). Recently, a meta-analysis for investigate surgical complications of SB and PPV in RRD showed no significant difference between SB and PPV in terms of the rate of CME in the long-term postoperative period [23]. In the present study, the rate of CME in the long-term postoperative period was the highest, but not significant, in the PPV+Silicone group (n=10, 25%; P>0.05). In their study, Kiss et al [20] investigated the macular changes after silicone oil removal in patients with complicated retinal detachment with PVR. They reported that 12.8% of their patients had clinically normal macula and 18% of their patients had CME. In another study in which macular microstructures were analyzed via spectral-domain OCT before and after silicone oil removal, CME was reported in 19.6% of the patients and the mean duration of tamponade was indicated to be significantly longer in eyes with macular changes [24]. Asaria et al [25] analyzed intraocular fluid and vitreous specimens of patients who underwent silicone oil removal, revision or primary vitrectomy for MH, PVR or retinal detachment and found increased levels of basic fibroblast growth factor, interleukin-6, and protein in the retro-oil fluid as compared to all other fluid samples (vitreous and vitreous cavity samples). These factors might theoretically promote the formation of CME, proliferation of retro-oil perisilicone, and then formation of fibrocellular membrane.

Persistent IOP elevation is a common complication following PPV. It has been reported that

this elevation might result from intraocular tamponade usage, peripheral anterior synechiae, rubeosis iridis and neovascular glaucoma, encircling, long-term topical steroid use, or surgical trauma. The use of intraocular tamponade substances is defended as the leading cause [22, 26, 27]. Encircling may narrow the anterior chamber angle by impairing episcleral venous circulation or causing congestion in the ciliary body [28, 29]. In their studies, Billington and Leaver reported that the risk of IOP elevation following surgery was higher in the patients undergoing PPV together with SB [30, 31]. In the present study, the rates of persistent IOP elevation in the long-term postoperative period was 16.1% (n=5) in the SB group, 2.8% (n=1) in the PPV+Gas group, 17.5% (n=7) in the PPV+Silicone group, and 20% (n=4) in the SB+PPV group. However, the difference between the groups was not significant. Higher persistent IOP elevation in the PPV+Silicone group than in the PPV+Gas group suggested the importance of intravitreal tamponade selection. Therefore, preferring gas as a tamponade appears to be more reasonable.

Proliferative vitreoretinopathy may develop following any surgery performed to repair retinal detachment. PVR is characterized by the proliferation of retinal epithelial pigment cells and glial cells, production of extracellular matrix on and under the retinal surface, cellular contraction of these membranes, tangential retractions, and fixed retinal folds. Giant break, large or multiple breaks, presence of uveitis, aphakia, vitreous hemorrhage, and presence of preoperative choroidal detachment enhance the risk of PVR [32-34]. Development of postoperative PVR seems to be associated with the degree of preoperative PVR, uveitis, intraoperative or postoperative vitreous hemorrhage, extensive cryotherapy, diathermy or photocoagulation, repeated surgical interventions, fluid loss during subretinal fluid drainage, undetected and thus unrepaired retinal breaks, the use of sterile air or sulphur hexafluoride (SF₆), and postoperative choroidal detachment [35]. Another important point is the fact that development of postoperative PVR cannot be completely prevented and development process continues even if all retinal breaks have been successfully repaired [33]. PVR occurs in the postoperative 6-12 weeks at a rate of 2%-17% [36]. In previous studies on the patients with PRD, the rate of PVR after PPV has been report-

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ed to vary from 6% to 9% [37, 38]. In a study, the rates of PVR have been reported as 4% and 20% in the patients undergoing PPV and SB, respectively [39]. In the present study, the rates of PVR were 16.1% (n=5) in the SB group, 13.9% (n=5) in the PPV+Gas group, 15% (n=6) in the PPV+Silicone group, and 20% (n=4) in the SB+PPV group. No significant difference was determined among the groups regarding the frequency of PVR in the long-term postoperative period ($P>0.05$).

In pseudophakic eyes, there occur approximately a myopic shift of -0.5 D after vitrectomy surgery; the reason for this refractive change is unclear [40]. In SB surgery, refractive changes occur due to decreased diameter because of the effect of encircling, anterior displacement of the lens-iris diaphragm, lengthening or shortening of the anteroposterior axis, or corneal irregularities [41]. A spherical equivalent refraction over 2 D occurs in local buckling and encircling surgeries. Change in refraction is more remarkable after combined surgeries. There is a correlation between the refractive change and encircling height [42]. In the present study, while the spherical equivalent refraction was lower than 1 D in all patients undergoing PPV, the refractive change was >2 D in 29% (n=9) of the patients in the SB group and in 30% (n=6) of the patients in the SB+PPV group. The rate of anisometropia was significantly higher in the SB+PPV and SB groups than in the other groups ($P<0.001$).

A well-known complication after SB performed for retinal detachment is EOM dysfunction/diplopia. Diplopia generally results from ocular motility disturbances. It has been reported that persistent EOM dysfunction following buckling surgery is observed in approximately in 4% of the patients and mostly occurs in eyes with an encircling element [43]. In their meta-analysis, Lv et al [23] reported EOM dysfunction/diplopia as late postoperative complication in 14 (2.7%) of 520 eyes after SB and in 2 (0.5%) of 439 eyes after PPV, with a significant difference between the groups. In the present study, EOM dysfunction and related diplopia was observed only in 2 (6.5%) patients in the SB group leading to a significantly higher rate of EOM dysfunction/diplopia in the SB group ($P<0.05$) as compared to the other groups. Both patients with EOM dysfunction had restricted inward eye movement.

Formation of MH after retinal detachment repair is not a common condition. Benzerroug et al [44] reported MH in 9 (0.9%) of 1007 patients undergoing surgery for retinal detachment repair. In the present study, MH was observed in 2 (1.7%) patients, of whom one was from the SB group and the other was from the PPV+Silicone group.

There are several limitations of our present study. Firstly, the number of patient in study was only limited to 30-40 patients in each group. Secondly, this was a retrospective, comparative case series of a single center's experience. Thirdly, in present study, one of the surgeons chose to perform SB, the other surgeon performed PPV. So, these results may reflect their surgical expertise and it may difficult to extrapolate these data to the general vitreoretinal surgeon population.

In conclusion; the present study comparatively analyzed the complication rates in patients with PRD who had been treated by various surgical techniques. The frequency of many long-term surgical complications following SB, PPV (gas or silicone oil) or combined surgical procedures, which were performed for PDR repair, was similar. SB unfavorably influences functional vision as it is associated with increased risk of anisometropia and EOM dysfunction. Therefore, potential risk of development of such complications should be considered while preferring SB or combined procedure.

Disclosure of conflict of interest

None.

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