Outcomes of Inferior Retinectomy in Patients with Recurrent Rhegmatogenous Retinal Detachment due to Proliferative Vitreoretinopathy

Rüveyde Garip[1], Ece Özal[2], Sultan Kaya[3], Sadık Altan Özal[4]

ABSTRACT

Purpose: The aim of this study was to evaluate and report the complication rates, and anatomical and functional outcomes of eyes undergoing inferior retinectomy for the management of recurrent rhegmatogenous retinal detachment (RRD) due to inferior proliferative vitreoretinopathy (PVR).

Materials and Methods: This retrospective, non-comparative, interventional case series was conducted with 32 eyes of 32 patients with recurrent RRD due to inferior PVR who had previously undergone 23-gauge pars plana vitrectomy (PPV) and inferior retinectomy. Demographic data, and preoperative, intraoperative and postoperative characteristics were evaluated from the medical records of the patients. The anatomic and functional success were considered as the primary outcomes. The secondary outcome was the postoperative complications.

Results: The mean follow-up time after the PPV with retinectomy was 10.6 ± 4.9 (min. 6, max. 24) months. After the initial retinectomy, anatomic success was achieved in 22 (68.7%) patients. Overall, the retinas of 27 patients (84.4%) were successfully reattached after retinectomy and PPV at the last visit. The mean best-corrected visual acuity (BCVA) improved from 1.72 ± 0.97 LogMar (range, 3.0-0.4 LogMar) to 1.20 ± 0.65 LogMar (range, 3.0-0.3 LogMar) at the final visit. There was a statistically significant increase in visual acuity postoperatively ($p = .01$). At the last visit, BCVA was improved in 19 eyes (59.4%), stabilized in 8 eyes (25%) and decreased in 5 eyes (15.6%). The most significant factor affecting the final BCVA was the baseline visual acuity ($p = .002$). Two patients (6.2%) developed hypotonia postoperatively. None of the cases presented with endophthalmitis, keratopathy or postoperative phthisis bulbi.

Conclusion: Inferior retinectomy is effective in managing recurrent RRD cases due to inferior PVR and can increase functional success rates.

Keywords: inferior retinectomy; pars plana vitrectomy; proliferative vitreoretinopathy; recurrent retinal detachment; rhegmatogenous retinal detachment

INTRODUCTION

Proliferative vitreoretinopathy (PVR) is a serious complication of rhegmatogenous retinal detachment (RRD). It is the most common cause of RRD repair failure and occurs in approximately 5% to 11% of patients.[1,2] PVR is characterized by the proliferation of cells on either the retinal surface or in the vitreous cavity, leading to the formation of contractile preretinal membranes. These contractile membranes cause retinal re-detachment or transform a rhegmatogenous detachment into a tractional detachment by shortening the retina.[3, 4] Since endotamponade materials cannot adequately cover the inferior quadrant of the retina, severe PVR most often develops in the inferior circumference of the retina and leads to recurrent retinal detachment.[5]

Scleral buckling (SB) surgery combined with pars plana vitrectomy (PPV) was the most widely used surgical procedure to treat recurrent RRD due to inferior PVR until a few years ago. Today, since SB surgery involves complications, such as scleral perforation, prolonged

1- Asst. Prof. MD, Trakya University School of Medicine, Department of Ophthalmology, Edirne, Turkey

2- MD, Edirne Sultan 1. Murad State Hospital, Department of Ophthalmology, Edirne,Turkey

3- MD, Trakya University School of Medicine, Department of Ophthalmology, Edirne, Turkey

4- Assoc. Prof., MD, Trakya University, School of Medicine, Department of Ophthalmology, Edirne, Turkey

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Correspondence Adress:
Sadık Altan Özal
Trakya University, School of Medicine, Department of Ophthalmology, Edirne, Turkey
Phone: +90 284 236 0910
E-mail: altanozal@hotmail.com

surgery time, myopic shift, diplopia, choroidal haemorrhage, buckle erosion and anterior segment ischemia, PPV surgery has become the first option in the treatment of recurrent RRD due to inferior PVR.[6] However, additional manoeuvres are required in PPV surgery in the treatment of recurrent RRD due to inferior PVR. Several techniques have been described to treat recurrent RRD with severe PVR. These techniques may include extensive membrane peeling from the posterior pole to the vitreous base, inferior circumferential retinectomy/retinotomy, postoperative perfluoro-n-octane retention and intraocular tamponade with heavy silicone oil.[2,7-9] The purpose of all surgical techniques is to attach the retina by increasing the endotamponade effect on the inferior quadrants of the retina. Most of the studies evaluating these techniques have shown satisfactory reattachment rates postoperatively.[10,11,12,13]

Retinectomy was first described by Machemer in 1979 and is used for the management of selected retinal detachments.[14] Retinectomy consists of cutting and removing the peripheral portion of retina combined with cryotherapy or laser retinopexy and intraocular tamponade (gas or silicone oil).[2,15,16] In recent years, various publications have outlined the anatomical and functional success of retinectomy in the repair of recurrent RRD due to inferior PVR. These studies have reported variable success and complication rates.[2,10,12,13]

The aim of this study was to evaluate and report the complication rates, and anatomical and functional outcomes of eyes undergoing inferior retinectomy for the management of recurrent RRD due to inferior PVR.

MATERIALS AND METHODS

This retrospective, non-comparative, interventional case series was conducted with 32 eyes of 32 patients with recurrent RRD due to inferior PVR who had previously undergone 23-gauge PPV and inferior retinectomy at a university teaching centre from January 2018 to October 2019. This study was carried out according to the principles of the Declaration of Helsinki (2013) and was approved by the local ethics committee. Informed consent was obtained from all participants before the surgery was performed.

Patients who were at least 18 years of age, had recurrent RRD due to inferior PVR (grade C) and had had regular follow-ups after retinectomy for at least 6 months were included in the study. All of the operations were performed by a single surgeon (SAO). PVR grading was performed according to the classification developed by the Retina Society.[17] Exclusion criteria included eyes that had previously undergone SB surgery, had primary RRD, non-RRD, macular holes, endophthalmitis, an intraocular foreign body, proliferative diabetic retinopathy, penetrating trauma, retinal vascular diseases, inflammatory eye diseases or age-related macular degeneration.

Demographic data such as age, gender and laterality, and preoperative, intraoperative and postoperative characteristics were evaluated from the medical records of the patients. Preoperative characteristics included duration of symptoms, best-corrected visual acuity (BCVA), crystalline lens status, intraocular pressure (IOP), the extension of RRD (as clock hours), the grade of PVR, macular attachment status (macula-on or macula-off), previous surgeries and the number of retinal tears. Intraoperative and postoperative characteristics included the extension of retinectomy (as clock hours), type of intraocular tamponade, recurrence of PVR, RRD persistence, IOP, further re-operations, final BCVA and complications such as hypotony, glaucoma and cystoid macular oedema. Hypotony was defined as an IOP of less than 5 mmHg. IOP values more than 25 mmHg were considered elevated.

The primary outcomes were anatomic success, defined as complete retinal reattachment at least 6 months after surgery, and functional success, defined as a statistically significant improvement or stabilization of the BCVA at the final follow-up. The change in visual acuity was considered to be at least one line change in Snellen visual acuity or changes between light perception (LP), hand motion (HM) and counting finger (CF). The secondary outcome was postoperative complications.

Surgical procedure

The surgical technique included 23-gauge PPV using a Infinity Constellation (Alcon, Fort Worth, TX, USA) vitrectomy device, Leica M844 F40 (Leica, Wetzlar, Germany) surgical microscope and Eibos 1 (Haag-Streit, Koeniz, Switzerland) non-contact, wide-angle viewing system. Combined phacovitrectomy (phacoemulsification and PPV) and intraocular one-piece lens implantation were performed in all phakic patients. After intraocular lens implantation into the capsular bag, three 23-gauge trocars were inserted from the pars plana level to 4 mm behind the limbus. First, silicone oil that had been implanted as an internal tamponade during the previous surgery was removed. In all cases, a 25-gauge trocar was inserted and a chandelier light source was placed. In the case of phakic patients where vitreous base cleaning was not performed in the previous surgery, 360-degree vitreous base cleaning was performed with a scleral depressor after the removal of the lens. The meticulous removal of the preretinal membranes was carried out with forceps after staining them with membrane blue-dual (DORC, Zuidland, Netherlands). The membrane peeling was performed not only up to the vitreous base but in a more limited area only on the posterior pole. After the removal of the membranes and vitreous base, air-fluid exchange was performed and the size of the retinectomy area was determined. Endodiathermy was applied to the retina at the edge of the retinectomy area. Perfluorocarbon fluid was injected into the retina at the edge of the retinectomy area. The retinectomy was performed with the vitreous cutter in patients with insufficient retinal relief in the inferior quadrant of the retina and extended circumferentially as far as necessary to relieve all tractions. An extension of the retinectomy area ranged from 2-6 clock hours. Mild bleeding occurred in most cases. In cases with more serious bleeding, it was controlled by increasing the infusion bottle height and applying endodiathermy if needed. The peripheral retina at the anterior of the retinectomy area was removed with a vitreous cutter to prevent re-proliferation and ciliary body detachment. After the completion of the retinectomy, laser endophotocoagulation was applied 360-degrees to the peripheral retina and posterior to the free edge of the cut retina. In the end, direct perfluorocarbon liquid–silicone oil exchange was performed. Silicone oil of 5000 centistokes (cSt; Teknomek, Istanbul, Turkey) was used in all cases as an internal tamponade. All of the sclerotomies were sutured with 7.0 Vicryl.

Postoperatively, patients were instructed to posture with their face down for 2 weeks. Follow-up intervals were determined according to the clinical course of each patient. At each visit, a complete ophthalmic examination was performed, and 3 outcomes were considered: postoperative BCVA (improved or stabilized), whether or not the retina was attached at the end of the follow-up period and whether or not the eye had developed any complications.

Statistical analysis

Statistical analysis was done using SPSS version 20 (SPSS, Inc., Chicago, IL, USA). All BCVA data were converted to logarithm of the minimum angle of resolution (LogMAR) visual acuity for statistical analysis. CF and HM vision were converted to a LogMAR of 2.0 and 3.0, respectively. The normality of data was checked using the Kolmogorov–Smirnov test. The distribution of all variables was examined using frequency tables and descriptive statistics. Descriptive data were presented as mean ± standard deviation (SD). An independent sample t-test was used to compare independent variables when the normal distribution was observed, and the Mann–Whitney U test was used when the normal distribution was rejected. A paired sample t-test was used to compare dependent variables when the normality was assumed, and the Wilcoxon signed-rank test was used when the normal distribution was rejected. A chi-square test was used to assess the relationship between the categorical variables. The relationship of the final BCVA with the prognostic factors was examined using the Spearman rank correlation test. In addition, a multilinear regression model was applied to evaluate the relationship between functional outcomes and prognostic factors. All tests were considered to be statistically significant if $p < .05$.

RESULTS

A total of 32 eyes from 32 patients, 8 (25%) of which were female and 24 (75%) of which were male, with an average age of 64.5 years (range, 28-83 years) were included in this study. The mean follow-up time was 20.8 ± 8.6 (min. 9, max. 40) months after the initial surgery. The retinal detachment time between the prior surgery and the PPV with retinectomy was on average 26.3 days (range, 7-80 days). There were 28 eyes (87.5%) that had undergone 1 prior PPV and 4 eyes (12.5%) that had undergone 2 prior PPV. The mean follow-up time after the PPV with retinectomy was 10.6 ± 4.9 (min. 6, max. 24) months.

Twenty-nine (90.6%) eyes were pseudophakic and 3 (9.4%) eyes were phakic. In phakic eyes, combined phacovitrectomy (phacoemulsification with intraocular lens and PPV) was performed. The extension of RRD was 1-3 clock hours in 11 (34.4%) eyes, 4-6 clock hours in 14 (43.7%) eyes, 7-9 clock hours in 2 (6.3%) eyes and 10-12 clock hours in 5 (15.6%) eyes. All of the patients had PVR (grade C). Fifteen (46.8%) patients had macular detachment. A retinectomy was performed in 7 eyes (21.9%) with an extension of 1-3 clock hours and in 25 eyes (78.1%) with an extension of 4-6 clock hours. The mean retinectomy extension size was 4.87 ± 1.43 clock hours (range, 2-6 clock hours). Silicone oil was removed from 25 (78.1%) eyes. Silicone oil was not removed in a total of 7 eyes (21.9%). The mean time between the retinectomy and silicone oil removal was 5.2 ± 4 months. Preoperative, intraoperative and postoperative characteristics are summarized in Table 1.

After the PPV with retinectomy, anatomic success was achieved in 22 (68.7%) patients. In 10 (31.2%) patients, the retinectomy was considered to be a failure. Among these patients, 1 patient underwent additional PPV and the retina was reattached. In 4 patients, the area of the detached retina was controlled using laser photocoagulation, and

Table 1: *Preoperative, intraoperative and postoperative characteristics of patients.*

Characteristics	Patients, n (%)
Preoperative	
Prior PPV	
One	28 (87.5)
Two	4 (12.5)
Tamponade use	
Silicon oil	24 (75)
SF6/C3F8	8 (25)
Lens status	
Phakic	3 (9.4)
Pseudophakic	29 (90.6)
Extension of retinal detachment	
1-3 clock hours	11 (34.4)
4-6 clock hours	14 (43.7)
7-9 clock hours	2 (6.3)
10-12 clock hours	5 (15.6)
Macula status	
On	17 (53.2)
Off	15 (46.8)
Intraoperative	
Retinectomy extension	
1-3 clock hours	23 (71.9)
4-6 clock hours	9 (28.1)
Postoperative	
BCVA	
Visual improvement	19 (59.4)
Unchanged BCVA	8 (25)
Decreased BCVA	5 (15.6)
Retina status	
Retinal attachment	27 (84.4)
Detached retina	5 (15.6)
Complications	
Hypotonia	2 (6.25)
Glaucoma	3 (9.4)
Cystoid macular oedema	10 (31.25)
Macular pucker	12 (37.5)

PPV: pars plana vitrectomy; **BCVA**: best-corrected visual acuity.

silicone oil was not removed in 2 of these patients. In 3 patients, the surgeon decided not to perform additional surgery because of the risk/benefit ratio and a further 2 patients refused additional surgery. Also, silicone oil was not removed in these 5 patients. Thus, overall, the retinas of 27 patients (84.4%) were successfully reattached with inferior retinectomy and PPV.

There was no significant relationship between the anatomical success and age ($p = .411$), sex ($p = .66$), detachment time ($p = .56$), detachment area ($p = .09$), number of tears ($p = .68$) and retinectomy extension ($p = .45$). However, we did find a relationship between preoperative visual acuity and anatomical success ($p = .045$). Anatomical success rate was found to be higher in patients with an initial BCVA greater than 20/400 than those less than 20/400 ($p = .04$).

Preoperative BCVA was 1.72 ± 0.97 LogMar (range, 3.0-0.4 LogMar). BCVA was 1.20 ± 0.65 LogMar (range, 3.0-0.3 LogMar) at the final visit. There was a statistically significant increase in visual acuity postoperatively ($p = .01$). Preoperatively, there were 15 (46.9%) eyes that were ≥ 20/400 and 17 (53.1%) eyes that were CF or worse. Postoperatively, 22 (68.7%) eyes were ≥ 20/400 and 10 (31.2%) eyes were CF or worse. At the last visit, BCVA was improved in 19 eyes (59.4%), stabilized in 8 eyes (25%) and decreased in 5 eyes (15.6%). The change in BCVA values is shown in Figure 1.

Postoperative visual acuity was strongly correlated with preoperative visual acuity ($r = 0.77$, $p = .01$). There was a moderate negative correlation between the detachment area and the final BCVA ($r = -0.497$, $p = .005$). In patients with BCVA ≥ 20/400, the detachment area was significantly less than those who had < 20/400 visual acuity ($p = .019$). Better visual outcomes were obtained in macula-on detachments compared to macula-off detachments ($p = .003$). There was no relationship between the final BCVA and retinectomy extension ($r = -0.310$, $p = .09$), age ($r = 0.16$, $p = .39$), sex ($p = .46$), detachment time ($r = -0.154$, $p = .416$) and number of tears ($r = -0.246$, $p = .19$). The most significant factor affecting the final BCVA was the baseline visual acuity ($p = .002$, 95% confidence interval). The effect of preoperative and intraoperative characteristics on visual outcome is summarized in Table 2.

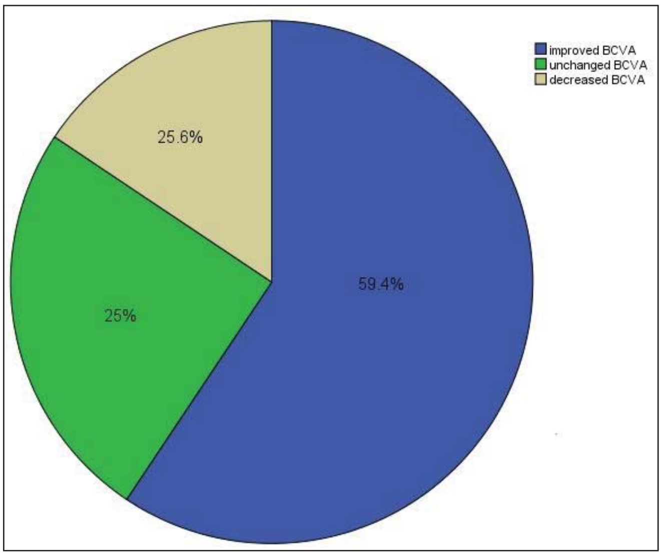

Figure 1: *Change in the best-corrected visual acuity (BCVA) values.*

Table 2: *Influence of preoperative and intraoperative characteristics on visual outcomes.*			
	BCVA ≥ 20/400	**BCVA < 20/400**	**P value**
Patients, n (%)	22 (68.75)	10 (31.25)	
Age (mean ± SD)	63.05 ± 11.42	68 ± 14.13	.29*
Gender			.66**
Male (%)	16 (50)	8 (25)	
Female (%)	6 (18.75)	2 (6.25)	
Macula status			.01**
Macula-on (%)	15 (46.8)	2 (6.2)	
Macula-off (%)	7 (21.8)	8 (25)	
Extent of retinal detachment (mean ± SD clock hours)	4.18 ± 1.86	7.80 ± 3.96	.001*
Extension of retinectomy			.86**
1-3 clock hours (%)	5 (15.6)	2 (6.2)	
4-6 clock hours (%)	17 (53.2)	8 (25)	
BCVA: best-corrected visual acuity; **SD:** standard deviation; *: Independent sample t-test; **: Pearson chi-square test			

No intraoperative complications were observed, except mild-to-moderate bleeding. The bleeding was controlled by the elevation of IOP and thermal cauterization. Hypotonia was present in 2 (6.2%) cases before the retinectomy procedure. IOP reached normal levels in the postoperative period of 1 of the patients with preoperative hypotonia. However, in the other case, hypotonia persisted postoperatively. Postoperative hypotonia was observed in 1 of the patients with normal IOP in the preoperative period. Overall, hypotonia was observed in 2 (6.2%) patients at the last visit. In 3 eyes, glaucoma developed postoperatively and antiglaucomatous medication was administered. In these cases, IOP was controlled with antiglaucomatous medication. Significant cystoid macular oedema was observed in 10 eyes (31.2%). These patients received an intravitreal dexamethasone implant to treat cystoid macular oedema. Macular pucker formation was seen in 12 eyes (37.5%). However, none of the cases presented with endophthalmitis, keratopathy or postoperative phthisis. When the effect of the retinectomy extension on postoperative complications was evaluated, it was seen that in both cases with postoperative hypotonia, a retinectomy extension of 4-6 clock hours had occurred. In addition, it was found that patients with 4-6 clock hours of retinectomy extension developed an increased rate of cystoid macular oedema than patients with 1-3 clock hours of retinectomy extension ($p = .034$).

DISCUSSION

Despite improvements in surgical techniques, PVR remains the most important cause of unsuccessful RRD surgery and poor visual outcomes.[12,18] Relaxing retinectomies are required to relieve the retina even after the removal of all the membranes.[10,18] In our case series, the anatomic success rate was 68.7% after the first retinectomy and the final retinal attachment rate was 84.4%. These results are compatible with other studies evaluating the effect of retinectomy on retinal detachment with PVR that report final success rates ranging from 40% to 97%.[2,12,18,19,20,21,22] Some studies comparing retinectomy results have included various diseases that cause PVR such as trauma, RRD, vasculitic diseases and endophthalmitis.[3,19,23] In the study of Tan et al., which included primary RRD and recurrent cases, the first anatomic success rate was reported as 77.2% and the final anatomic success rate was reported as 95.9%.[20] Tranos et al. reported the initial anatomic success rate as 80% and the final anatomic success rate as 84% in isolated RRD cases.[7] Quiram et al. reported the anatomical success rate in recurrent RRD cases undergoing inferior retinectomy as 60% after the first retinectomy and 93% after additional surgeries.[2] The variability in the results can be attributed to the surgeon and surgical technique, the severity of the disease and the variability of inclusion and exclusion criteria.

In accordance with similar publications in the literature, we did not find a relationship between anatomical success and retinectomy extension.[19,20] The anatomic success rate was higher in patients with baseline visual acuity ≥ 20/400 compared to those < 20/400. This can be explained by the fact that the disease is more severe in patients with lower baseline visual acuity.

In the present study, it was found that preoperative visual acuity increased significantly in the postoperative period. The mean LogMar value increased from 1.72 preoperatively to 1.20 postoperatively. Final BCVA ≥ 20/400 was reached in 68.7% of patients. We achieved 84.4% improvement or stabilization and 15.6% deterioration in visual acuity. Tranos et al. included RRD with PVR in their study and found a 94% improvement or stabilization in visual acuity and a 6% deterioration.[7] Tan et al. reported that they found improvement or stabilization in 102 eyes (83%), and worsening in visual acuity in 21 eyes (17%).[20] In their series, Grigoropoulos et al. reported a 69% improvement or stabilization in visual acuity and a 29% deterioration.[19] It may be argued that the reason for the lower rates in the findings of Grigoropoulos et al. are due to the fact that their study involves RRDs as well as PVR cases developed due to trauma and vasculitic diseases. De Silva et al. reported significantly poorer visual outcomes in patients with retinal detachment with PVR accompanied by intraocular inflammation, such as posterior uveitis and endophthalmitis, to support this hypothesis. They proposed that underlying proinflammatory cytokines and cellular mediators in these eyes increase the PVR response, causing poor visual outcomes.[3] In another study, Adıgüzel et al. reported the functional success rates as 20% in traumatic retinal detachment group, and as 54% in nontraumatic retinal detachment group.[23] Our findings in this study, which included cases with isolated RRD, are consistent with those of Tan et al.[20] and Tranos et al.[7]

In the present study, it was found that the only factor that affects the final BCVA was the baseline visual acuity. We observed that patients with good preoperative visual acuity had better final visual outcomes. Tan et al.[20] and Grigoropoulos et al..[19] reported that final BCVA was associated with preoperative visual acuity and retinectomy size. They considered the larger extension of the retinectomy to be a risk factor for poor visual outcomes. However, de Silva et al.[3] and Shalaby.[24] found no statistically significant relationship between the size of the retinectomy and the final BCVA. In our study, we did not find a relationship between the size of the retinectomy and the final BCVA. We observed that patients with ≥ 20/400 visual acuity had higher initial visual acuity, less macular involvement and a smaller detachment area.

Retinal fold formation during fluid perfluorocarbon – air exchange is one of the important intraoperative complications in large retinectomy cases.[25] In the present study, direct perfluorocarbon liquid–silicone oil exchange was performed. Retinal fold was not observed in any of the cases in the intraoperative and postoperative period. Corneal complications due to silicone oil after vitreoretinal surgery develop as a result of endothelial toxicity, which occurs when silicone oil enters the anterior chamber and contacts the endothelium.[16] In various reports, the rate of corneal complications varies 22% to 43%.[26, 27] Çakır et al. reported that 19% of their cases developed band keratopathy despite using high-viscosity silicone oil. They thought that this was related to the fact that they did not remove silicone oil in any of the eyes. In the present study, silicone oil emulsification and keratopathy were not observed in any of the cases. In these cases, the use of high-viscosity silicone oil and the removal of silicone oil both increase functional success rates, and reduce corneal complications.[19]

Hypotonia is one of the most common complications seen after PPV with retinectomy. In various reports, the rate of hypotonia varies from 4.1% to 40%.[18, 20, 21, 28] In our study, the rate of hypotonia was 6.2%, which is in accordance with the literature. Although the exact mechanism of hypotonia is not well-known, fibrosis may cause traction in the ciliary body and lead to ciliary detachment and, consequently, a decrease in aqueous production.[29] Another mechanism proposed in postoperative hypotonia is the reabsorption of fluid from the widely exposed retinal pigment epithelium.[30] Based on this knowledge, some reports have demonstrated a relationship between large retinectomy size and postoperative hypotonia.[31] This knowledge is still controversial and there are reports showing that there is no relationship between the width of the retinectomy and hypotonia.[7,12] Another factor that has been shown to be associated with postoperative hypotonia is the use of silicone oil as a tamponade. Hypotonia was reported to occur less in eyes in which silicone oil was used as a tamponade.[3, 19, 24] We observed that 2 cases with hypotonia had a 4-6 clock hour extension of the retinectomy. Hypotonia was not observed in patients who had undergone a retinectomy for 1-3 clock hours. We attributed hypotonia occurring at a lower rate to be due to our smaller retinectomy size and use of silicone oil as a tamponade in all cases. In our study, we also removed the anterior portion of the inferior retinectomy area. This method may have contributed to achieving low postoperative hypotonia rates by preventing the development of peripheral neovascularization, re-proliferation and ciliary body detachment. We performed the membrane peeling not only up to the vitreous base but in a more limited area only on the posterior pole. We believe that this technique would shorten the duration of surgery by preventing diffuse membrane peeling and difficult surgical manoeuvres in the peripheral retina. In addition, we concluded that lens removal and radical anterior base dissection, which we performed with a chandelier light in all cases, may be responsible for our improved anatomical results by reducing the development of anterior PVR.

This study has several limitations that should be mentioned. Our case series is retrospective in nature, has a small sample size and has no control group including eyes undergoing combined PPV and SB surgery. On the other hand, the application of the same surgical technique in all patients, all operations performed by the same surgeon and the homogeneous distribution of the study group increase the importance of our results.

In conclusion, inferior retinectomy in conjunction with PPV is a useful surgical technique with high anatomical and functional success rates and relatively low complication rates in the treatment of recurrent RRD cases due to inferior PVR.

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