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ORIGINAL PAPER

Primary vitrectomy with short-term silicone oil tamponade for uncomplicated rhegmatogenous retinal detachment

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Abstract
Purpose To compare the outcomes of phakic and pseudophakic uncomplicated rhegmatogenous retinal detachment (RRD) treated with primary pars plana vitrectomy (PPV) and short-term silicone oil (SO) tamponade.
Methods A retrospective chart review of 201 eyes (185 patients) with uncomplicated RRD treated with primary 23-gauge PPV and short-term SO tamponade. Anatomical success was defined as a reattached retina for at least 6 months after SO removal.
Results The analysis consisted of 111 phakic eyes and 90 pseudophakic eyes. The mean duration of SO tamponade in phakic eyes was 8.5 ± 1.9 and in pseudophakic eyes was 8.3 ± 1.9 months ($P = 0.39$). The primary reattachment rate was 93% in the phakic group and 98% in the pseudophakic group ($P = 0.19$). The mean Snellen VA equivalent at the final visit was 20/30 in both groups. Final VA ≥ 20/40 was achieved in 81% of phakic and 86% of pseudophakic eyes ($P = 0.69$). Postoperative complications included cataract in the phakic group (100%), transient elevation of intraocular pressure (IOP) (29%), epiretinal membrane (8%), proliferative vitreoretinopathy (7%), cystoid macular edema (3%), secondary macular hole (2%), persistent elevation of IOP (1.5%), and persistent hypotony (1%).
Conclusions The success rates and functional outcomes of primary 23-gauge PPV with short-term SO tamponade did not differ significantly between the two groups, suggesting that lens status is not the single most important factor influencing the final results. The use of short-term SO was not associated with keratopathy, visual loss without any apparent reason and high rates of chronic elevation of IOP or redetachment following SO removal.

Keywords Pars plana vitrectomy · Pseudophakia · Rhegmatogenous retinal detachment · Silicone oil

Introduction

Despite advances in vitreoretinal techniques, rhegmatogenous retinal detachment (RRD) remains one of the leading causes of visual impairment. Different surgical techniques for the management of RRD include pneumatic retinopexy, scleral buckling, pars plana vitrectomy (PPV), and combined techniques [1]. In recent years, there has been a growing trend toward PPV as the preferred method of treatment for uncomplicated RRD [2].

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During RD surgery, gases and silicone oil (SO) are used to provide surface tension across retinal breaks, which prevents further fluid flow into the subretinal space until the retinopexy provides a permanent attachment [3]. Unlike gases, SO is permanent and a second surgical procedure is needed to remove it. The choice of tamponade agent depends on the location and characteristics of the detachment, expected patient compliance with postoperative positioning requirements, and other factors. Silicone oil may be preferable in patients unlikely to comply with postoperative positioning, in monocular patients desiring faster visual rehabilitation, in patients planning air travel shortly after surgery, or if a moderate altitude ascent is inevitable during the postoperative period.

Another factor that could influence the results of PPV is the lens status. There is a risk of touching the lens, and access to the vitreous base is more difficult, possibly being the reason for a higher incidence of redetachment in these patients. In pseudophakic eyes, it is possible to approach the vitreous base directly, facilitating the recognition and management of intraoperative vitreoretinal pathology [4].

To the best of our knowledge, there are limited data on the effects of short-term SO tamponade and lens status in the outcomes of primary PPV for uncomplicated RRD [4, 5]. We compared phakic and pseudophakic uncomplicated RRD cases in a retrospective study of the safety and efficacy of 23-gauge primary PPV combined with short-term SO tamponade.

Methods

The medical records of 233 patients who underwent primary 23-gauge PPV with injection of SO for uncomplicated RRD at Istanbul Retina Institute between August 2006 and March 2016 were reviewed. The study protocol was approved by the Ethics Committee of Sisli Memorial Hospital, Istanbul. The study was in accordance with the principles of the Declaration of Helsinki.

Included were cases with uncomplicated RRD (grades 0, A, and B PVR) with follow-up of at least 6 months after SO removal. Excluded were eyes with RRD secondary to trauma, grade C PVR, giant retinal tears, and patients with incomplete medical records. Eyes were classified into two groups according to the initial lens status (phakic or pseudophakic). In general, SO was preferred over gas tamponade in patients at higher risk of surgical failure (inability to maintain a posture due to age or other systemic diseases, high myopia, failed RRD surgery in the fellow eye), single-eye patients desiring faster visual rehabilitation or patients planning air travel shortly after surgery or if a moderate altitude ascent was inevitable during the postoperative period.

Some of the patients had a history of lens exchange or refractive corneal surgery; preoperative refractive error was defined in these cases as a spherical equivalent on the basis of prerefractive surgery data. Elevated IOP was defined as an IOP higher than 21 mmHg. Hypotony was defined as an IOP of 5 mm Hg or less. Anatomical success was defined as a fully attached retina for a minimum of 6 months after SO removal, without the need for additional surgery, laser photocoagulation, or cryotherapy.

All primary PPV procedures were performed under general anesthesia by the same surgeon (MK) as previously described [6]. A 25- or 27-gauge chandelier illumination system was used to permit bimanual surgical intervention. The cortical vitreous was removed extensively, and the vitreous base was shaved using scleral indentation. Laser endophotocoagulation and/or transscleral cryotherapy was performed around all the breaks. All patients also had peripheral 360° endolaser photocoagulation. Finally, surgery was completed by air–oil exchange using 1000 cSt SO. Sclerotomies and the conjunctiva were closed with 8–0 vicryl suture. During the postoperative period, patients were advised to keep head positioning defined by the break location for 3–5 days. The SO was removed as early as possible using a three-port, 20-gauge technique via a pars plana approach under general or retrobulbar anesthesia by the same surgeon (MK) as previously described [7].

Statistical analysis

The two groups were compared using independent sample *t*-test for continuous variables and chi-square or Fisher's exact tests for categorical variables. $P < 0.05$ was considered statistically significant. Statistical analyses used SPSS version 20.0 (SPSS Inc, Chicago, IL, USA).

Results

Included were 201 eyes of 185 patients. The subjects were divided into two groups: phakic eyes ($n = 111$) and pseudophakic eyes ($n = 90$). Preoperative characteristics are summarized in Table 1. The pseudophakic group differed from the phakic group in its older age and higher rates of RRD in the fellow eyes. The preoperative refractive error could not be determined in 17 (8%) eyes (nine phakic and eight pseudophakic) owing to extensive detachment and lack of detailed clinical record documentation before presentation. Overall, 134 (66%) eyes had some degree of myopia or a history of refractive surgery for correction of myopia. The average time between cataract surgery or refractive lens exchange and RRD was 35.8 ± 38.0 months (range 1–180 months). The average time between refractive corneal surgery and RRD in eight eyes of the phakic group was 4.1 ± 3.9 years (range 1–13 years).

Intraoperative observations and procedures are summarized in Table 2. The pseudophakic group differed from the phakic group in its higher rate of detached posterior hyaloid membrane. Intraoperative complications noted during the initial vitrectomy in phakic eyes were iatrogenic retinal breaks ($n = 7$), lens touch ($n = 1$) suprachoroidal hemorrhage ($n = 1$). Intraoperative complications documented in pseudophakic cases were iatrogenic retinal breaks ($n = 2$) and suprachoroidal hemorrhage ($n = 2$). In 7 (3%) eyes, no break could be identified intraoperatively.

Postoperative outcomes are summarized in Table 3. The overall final anatomic success rate was 100%. The final visual outcomes were similar in both groups, with a significant portion of VA ≥ 20/40 in more than 80% of cases. In 10 (5%) eyes (eight phakic

Table 1 Preoperative characteristics

Characteristics	Overall ($n = 201$)	Phakic group ($n = 111$)	Pseudophakic group ($n = 90$)	*P*
Mean (SD) age (years)	54.8 ± 12.6	52.1 ± 13.4	58.3 ± 10.7	< 0.001[a]
Range	18–80	18–75	33–80	
Sex: female/male (%)	35/65	40/60	30/70	0.15[b]
Spherical equivalent refraction (diopters)				
Mean (SD)	− 3.0 ± 4.2	− 3.3 ± 4.2	− 2.7 ± 4.2	0.31[a]
Range	− 16.0- + 5.25	− 14.0 ± 2.25	− 16.0 ± 5.25	
Myopia				
Mild [< 3.0 D; *n* (%)]	61 (30)	32 (31)	29 (35)	0.57[b]
Moderate [3.0–6.0 D; *n* (%)]	25 (12)	14 (14)	11 (13)	0.95[b]
High [> 6.0 D; n (%)]	48 (24)	29 (28)	19 (23)	0.42[b]
Mean (SD) IOP (mmHg)	14.0 ± 3.0	14.3 ± 2.8	13.7 ± 3.3	0.14[a]
Peripheral retinal degeneration [*n* (%)]	48 (24)	28 (25)	20 (22)	0.62[b]
Previous argon laser photocoagulation treatment [*n* (%)]	31 (15)	17 (15)	14 (16)	0.96[b]
Duration of symptoms (SD; days)	6.9 ± 5.8	7.3 ± 5.8	6.5 ± 5.8	0.36[b]
RRD in the fellow eye [*n* (%)]	41 (20)	16 (14)	25 (29)	0.02[b]
Mean (SD) VA (LogMAR)	1.4 ± 1.1	1.4 ± 1.1	1.5 ± 1.1	0.66[a]
Mean Snellen VA equivalent	20/500	20/500	20/630	0.66[a]
Range	20/20–20/20.000	20/20–20/20.000	20/20–20/20.000	

SD standard deviation, *n* number, *VA* visual acuity, *D* diopters, *LogMAR* logarithm of the minimum angle of resolution

[a]Independent *t*-test

[b]chi-square test

Table 2 Observations and procedures during primary pars plana vitrectomy

Characteristics	Overall ($n = 201$)	Phakic group ($n = 111$)	Pseudophakic group ($n = 90$)	P
Mean (SD) duration of surgery (min)	45.6 ± 7.0	46.1 ± 6.2	45.0 ± 7.9	0.23[a]
Mean (SD) number of retinal breaks	2.35 ± 1.9	2.4 ± 1.9	2.3 ± 1.9	0.54[a]
Range	1–10	1–9	1–10	
Mean (SD) extend of RRD (quadrants)	3.0 ± 0.7	2.9 ± 0.7	3.0 ± 0.8	0.31[a]
Range	1–4	2–4	1–4	
Macula-off [*n* (%)]	170 (85)	93 (84)	77 (86)	0.73[b]
Vitreous hemorrhage [*n* (%)]	34 (17)	21 (19)	13 (14)	0.40[b]
Suprachoroidal hemorrhage [*n* (%)]	2 (1)	1 (0.9)	1 (1.1)	0.88[b]
Macular hole [*n* (%)]	2 (1)	1 (0.9)	1 (1.1)	0.88[b]
Posterior hyaloid				
Detached posterior hyaloid membrane [*n* (%)]	144 (72)	68 (61)	76 (84)	< 0.001[b]
Posterior hyaloid dissection [*n* (%)]	57 (28)	43 (39)	14 (16)	< 0.001[b]
Drainage retinotomy [*n* (%)]	45 (22)	23 (21)	22 (24)	0.53[b]
Drainage of SRF				
Drainage of SRF with perfluorocarbon liquid [*n* (%)]	149 (74)	85 (77)	64 (71)	0.37[b]
Drainage of SRF with fluid-air exchange [*n* (%)]	52 (26)	26 (23)	26 (29)	0.37[b]
Retinopexy				
Endolaser photocoagulation [*n* (%)]	201 (100)	111 (100)	90 (100)	0.10[b]
Endolaser photocoagulation + cryotherapy [*n* (%)]	36 (18)	18 (16)	18 (20)	0.49[b]

SD standard deviation, *RRD* rhegmatogenous retinal detachment, *n* number, *SRF* subretinal fluid, *PFC* perfluorocarbon

[a]Independent *t*-test

[b]chi-square test

and two pseudophakic, $P = 0.19$), further vitreoretinal surgery due to PVR under SO was required at a mean 10 weeks (range 8–12 weeks) after the initial vitrectomy and included SO removal (10) membrane dissection (10), retinotomy/retinectomy (2), endolaser photocoagulation (10), SO injection (10), and phacoemulsification with intraocular lens (IOL) implantation (1). Two of the phakic eyes underwent a third surgical intervention after the SO had been removed, including pars plana retinotomy/retinectomy, membrane dissection, endolaser photocoagulation, and SO injection due to PVR and tractional RD. By the final visit, SO had been removed in all patients.

Postoperatively, epiretinal membrane was recorded in 16 (8%) eyes, of which 9 (4%) eyes (six phakic and three pseudophakic) underwent epiretinal membrane (ERM) and internal limiting membrane (ILM) peeling during the SO removal. During follow-up, postoperative cystoid macular edema developed in 7 (3%) eyes (two after cataract surgery in the phakic group and five pseudophakic) and showed good response to intravitreal triamcinolone acetonide injection (3), topical nonsteroidal anti-inflammatory agents (2), and dexamethasone intravitreal implant (2), without further recurrence. A secondary macular hole after initial vitrectomy developed in 4 (2%) eyes (two phakic and two pseudophakic). The mean interval between RRD repair and macular hole formation was 9.8 ± 9.5 months (range 4–24 months). Vitreoretinal surgery, including ILM peeling with perfluoropropane tamponade, had been performed in three cases, and anatomical closure of the holes was achieved in two of these eyes.

Table 3 Postoperative outcomes and complications

Characteristics	Overall ($n = 201$)	Phakic group ($n = 111$)	Pseudophakic group ($n = 90$)	P
Mean (SD) follow-up (mo)	32.9 ± 26.4	37.3 ± 27.8	27.3 ± 23.7	0.008[a]
Range	6–122	6–122	6–97	
Primary anatomical success [*n* (%)]	191 (95)	103 (93)	88 (98)	0.19[c]
Final anatomical success [*n* (%)]	201 (100)	111 (100)	90 (100)	> 0.99
Reoperation [*n* (%)]	10 (5)	8 (7)	2 (2)	0.19[c]
Mean (SD) final VA (LogMAR)	0.2 ± 0.3	0.2 ± 0.3	0.2 ± 0.2	0.26[a]
Mean Snellen VA equivalent	20/32	20/32	20/32	0.26[a]
Range	20/20–20/2.000	20/20–20/2.000	20/20–20/400	
Final VA ≥ 20/40 [*n* (%)]	167 (83)	90 (81)	77 (86)	0.69[c]
Final VA 20/50 to 20/200 [*n* (%)]	31 (15)	19 (17)	12 (13)	0.69[c]
Final VA ≤ 20/400 [*n* (%)]	3 (1.5)	2 (2)	1 (1)	0.69[c]
Mean (SD) interval from PPV to silicone oil extraction (weeks)	8.4 ± 1.8	8.5 ± 1.9	8.3 ± 1.8	0.39[a]
Range	6–12	6–12	6–12	
Mean (SD) final IOP (mmHg)	14.1 ± 3.1	13.7 ± 3.1	14.6 ± 3.1	0.06[a]
Transient elevated IOP [*n* (%)]	58 (29)	26 (23)	32 (36)	0.06[b]
Persistent elevated IOP [*n* (%)]	3 (1.5)	2 (1.8)	1 (1.1)	0.69[b]
Persistent hypotony [*n* (%)]	2 (1.0)	1 (0.9)	1 (1.1)	0.88[b]
Fibrin membrane formation [*n* (%)]	25 (12)	12 (11)	13 (14)	0.44[b]
Conjunctival chemosis [*n* (%)]	15 (7)	7 (6)	8 (9)	0.48[b]
SO in anterior chamber [*n* (%)]	8 (4)	4 (3.6)	4 (4.4)	> 0.99[b]
Hyphema [*n* (%)]	11 (5)	7 (6)	4 (4)	0.76[b]
Epiretinal membrane [*n* (%)]	16 (8)	9 (8)	7 (8)	0.93[b]
Proliferative vitreoretinopathy [*n* (%)]	14 (7)	11 (10)	3 (3)	0.07[b]
Intravitreous hemorrhage [*n* (%)]	1 (0.5)	1 (0.9)	0 (0)	0.37[b]
Secondary macular hole [*n* (%)]	4 (2)	2 (1.8)	2 (2.2)	0.83[b]
Cystoid macular edema [*n* (%)]	7 (3)	2 (2)	5 (6)	0.25[c]
SO-induced keratopathy [*n* (%)]	0 (0)	0 (0)	0 (0)	> 0.99
Choroidal effusion/hemorrhage [*n* (%)]	0 (0)	0 (0)	0 (0)	> 0.99
Endophthalmitis [*n* (%)]	0 (0)	0 (0)	0 (0)	> 0.99
Complications after SO removal in the early postoperative period				
Transient hypotony [*n* (%)]	29 (14)	14 (13)	15 (17)	0.42[b]
Fibrin membrane formation [*n* (%)]	6 (3)	2 (1.8)	4 (4.4)	0.27[b]
Hyphema [*n* (%)]	5 (2.5)	2 (1.8)	3 (3.3)	0.49[b]
Intravitreous hemorrhage [*n* (%)]	4 (2)	2 (1.8)	2 (2.2)	0.83[b]
Choroidal effusion [*n* (%)]	2 (1)	0 (0)	2 (2.2)	0.11[b]

SD standard deviation, *SO* silicone oil, *IOP* intraocular pressure, *VA* visual acuity, *LogMAR* logarithm of the minimum angle of resolution

[a]Independent *t*-test

[b]Pearson chi-square test

[c]Fisher's exact test

Both groups were comparable with regard to the postoperative IOP. Transient elevation of IOP in the early postoperative period (1–4 weeks) was controlled successfully with topical and/or systemic antiglaucoma agents. Three eyes (1.5%) required topical antiglaucoma medications in order to control the IOP until their last follow-up (mean 32 months). Postoperatively, SO in the anterior chamber was recorded in 8 (4%) eyes. The anterior chamber SO was removed in two phakic eyes in the early postoperative period. In the remaining patients, SO in the anterior chamber was removed during the planned removal procedure. Early postoperative complications after SO removal are summarized in Table 3. Some degree of postoperative cataract formation was recorded in all phakic cases (100%). Phacoemulsification with intraocular lens (IOL) implantation was performed by the same surgeon (MK) in 101 (91%) of the phakic eyes (mean 8.9, range 3–29 months) after initial vitrectomy or during the revision surgery.

Discussion

This study shows that primary small-gauge PPV with short-term SO for uncomplicated RRD provides high anatomical success rates with favorable functional outcome and an acceptable rate of postoperative complications. An interesting finding was that primary anatomical success rates in both phakic (93%) and pseudophakic (98%) groups, with functional outcome $\geq$ 20/40 in more than $>$ 80% of eyes, were similar, indicating that lens status is not the single most important factor influencing final outcomes. Furthermore, the use of short-term SO tamponade was not associated with keratopathy, high rates of chronically elevated IOP, or redetachment following removal. Additionally, unexplained visual loss after SO use was not found in our series.

New advances in PPV systems, including wide-angle viewing systems, chandelier illumination, high-speed vitreous cutters, and perfluorocarbon liquids enable better visualization of the peripheral retina and retinal breaks, resulting in improvement of the final outcomes of RRD [8, 9]. In retrospective case series, PPV has been shown to have primary anatomical success rates ranging from 71 to 95% [10–16]. Peripheral vitreous shaving has been associated with a high reattachment rate in phakic, pseudophakic, and aphakic RRDs to more than 90% [10, 16]. Chaturvedi et al. [10] reported 95% single surgical reattachment rate after PPV with scleral depressed vitreous shaving, 360° peripheral endolaser, and C3F8 for uncomplicated RRD. The single surgical reattachment rate in phakic and pseudophakic eyes was not significantly different (93 and 97%, respectively). On the other hand, some RRD studies have had a single-procedure anatomical success rate in pseudophakic eyes higher than the same procedure in phakic eyes [17, 18]. The Pan-American Collaborative Retina Study reported 29% redetachment in phakic eyes subjected to primary vitrectomy and C3F8 injection, and 28% redetachment in phakic eyes subjected to vitrectomy and SO injection 12 months after SO removal. They hypothesized that residual vitreous may be involved in the lower success rates in these cases [17]. In this study, the primary anatomical success rates achieved in phakic (93%) and pseudophakic (98%) eyes were comparable with the results of Chaturvedi et al. [10]. We demonstrated that peripheral vitreous shaving with dynamic scleral depression may play a role in identifying primary retinal breaks and complete removal of the anterior vitreous, eliminating the scaffold needed for anterior PVR, which could increase the surgical success rate of PPV for RRD despite the lens status.

In terms of functional success, it is well known that successful anatomical reattachment does not always equate to significant improvement in VA, especially in cases with macula-off RRD. It has been suggested that the outer nuclear layer thickness and the status of the intermediate line are the most important predictors of visual outcome after successful RRD repair [19]. In this study, 83% of the eyes achieved final BCVA $\geq$ 20/40, while the rate of final BCVA $\geq$ 20/40 in macula-off eyes was 70%. Chaturvedi et al. [10] and Speicher et al. [20] reported final BCVA $\geq$ 20/40 in 66 and 80% of the macula-off eyes. Our results are consistent with previous reports suggesting that eyes with macula-off RRDs have the potential for good functional outcomes. On the other hand, Antoun et al. [5] in a prospective study including eyes with primary uncomplicated RRDs, a final vision of $\geq$ 20/40 was achieved in 43.5% of cases after PPV with SO tamponade. It has to be noted that there was a longer SO tamponade duration in this study (mean 5 months, range 2–12 months).

Proliferative vitreoretinopathy occurs in 5–10% of all RRD cases and therefore is the most common reason for surgery failure [21]. Some degree of postoperative PVR developed in 7% of the eyes in our series. In 5% of the eyes, revision surgery due to recurrent RRD associated with severe PVR was required. A retrospective case series of 141 patients who underwent primary RRD repair by PPV, laser, or cryotherapy and intraocular gas tamponade reported 12.8% postoperative ERM formation and 4.3% repeated surgery for removal of macular epiretinal membranes [22]. The rate of macular ERM formation (8%) and the rate of epiretinal membrane peeling during SO removal (4%) in our study population are consistent with previous reports. The development of ERM and PVR in eyes undergoing vitrectomy for RRD could be associated with the use of peripheral endolaser or cryotherapy for retinopexy, but the use of short-term SO tamponade does not seem to increase the rate of postoperative ERM or PVR formation.

The major problem with use of SOs as short- and long-acting tamponades is their ability to emulsify. The emulsifying droplets tend to promote dispersion and passage through the lens zonules or through retinal tears, causing inflammation, PVR, RRD failure, secondary glaucoma, and keratopathy [23]. A chronically IOP rise is quite common after vitrectomy with SO injection, with incidence ranging from 8 to 28% [24, 25]. In our study, transient elevation of IOP in the early postoperative period was recorded in 29% of the eyes and was controlled with antiglaucoma agents. During follow-up, only 1.5% of the eyes required topical antiglaucoma medications to control the IOP. None of the eyes developed SO-induced keratopathy during follow-up. The emulsification is time dependent, [23] and SO removal at the earliest possible time point seems to reduce the incidence of oil-related complications.

The most common reason for redetachment following SO removal is failure to identify and treat peripheral breaks by retinopexy. Additionally, incomplete dissection of the vitreous base during primary vitrectomy may leave residual vitreoretinal traction leading to detachment after SO removal. In a series including 147 eyes, the overall rate of redetachment following SO removal was 17.7%. There was a higher rate of redetachment in cases with a short SO tamponade duration of < 2 months [7]. Despite the shorter interval from PPV to oil extraction (mean 8.4 weeks) the retinal redetachment rate after SO removal in our study population was only 1%.

High rates of visual loss in 30% of the patients with RRD without macular involvement treated by vitrectomy and SO tamponade have been reported. The visual loss has been associated with a significant reduction in inner retinal thickness on optical coherence tomography, indicating neuronal cell loss in the macular area as a possible explanation. The duration of SO tamponade was the only significant factor related to the incidence of unexplained visual loss [26]. Visual loss after short-term SO use without any apparent reason did not occur in our series.

The incidence of cataract following vitrectomy varies between 6 and 100% [27]. Recently, we proposed that a longer interval from PPV to SO extraction could influence the safety and outcomes of cataract surgery [28]. The use of short-term SO may reduce the risk of cataract surgery complications.

In conclusion, phakic and pseudophakic eyes were comparable for anatomical success, visual recovery, and postoperative complications, suggesting that lens status is not the single most important factor influencing the final results. Small-gauge PPV with dynamic scleral depression, 360° peripheral endolaser photocoagulation, and short-term SO for uncomplicated RRD appears reasonable for monocular patients, patients at higher risk of surgical failure, and patients planning air travel shortly after surgery, achieving high anatomical and functional success and low complication rates. The primary limitations of this technique are the necessity to remove the SO in a second surgical procedure and cataract development. This study is limited by its retrospective nature, as well as its single-center design.

Compliance with ethical standards

Conflict of interest Author Murat Karacorlu declares that he has no conflict of interest. Author Mumin Hocaoglu declares that he has no conflict of interest. Author Isil Sayman Muslubas declares that she has no conflict of interest. Author M. Giray Ersoz declares that he has no conflict of interest. Author Serra Arf declares that she has no conflict of interest. Author Omer Uysal declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained prior to every surgical procedure from all individual participants included in the study.

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