Outcome of Scleral Buckling With or Without Gas Tamponade for Recurrent Retinal Detachment in Post-vitrectomy Eyes

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Research Article

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Abstract

Background: Treatment of recurrent retinal detachment (re-RD) following vitrectomy (post-gas/air tamponade and post-silicone oil removal) is challenging. Previously reported treatment is commonly revision pars plana vitrectomy (PPV) combined with tamponade, which is invasive and a burden both economically and emotionally when compared with scleral buckling (SB). The purpose of this study is to report anatomical and functional outcomes of SB with or without gas tamponade in eyes with recurrent retinal detachment (re-RD) that previously underwent PPV at least once.

Methods: We retrospectively reviewed the medical records of 14 patients (14 eyes) who underwent PPV at least once and were treated with SB after re-RD. Preoperative characteristics, intraoperative complications, and postoperative data were assessed. The final anatomical and functional outcomes were analyzed.

Results: The first PPV was performed for primary rhegmatogenous retinal detachment in 11 eyes, macular hole retinal detachment in 2 eyes, and myopic foveoschisis in 1 eye. Previously, 3 eyes underwent one PPV with gas tamponade, and the remaining 11 (79%) eyes underwent 2–5 operations. The re-RD involved the fovea in 7 (50%) eyes. There was no break detected in 2 eyes, suspected break in 5 eyes, 1 break in 4 eyes, 2 breaks in 2 eyes, and 3 breaks in 1 eye. Seven eyes underwent the procedure with gas injection. At the last follow-up, 13 eyes achieved total retinal attachment and 1 eye had re-RD. The postoperative intraocular pressure was within the normal range, except in 1 eye (6 mmHg). The finest postoperative best-corrected visual acuity (BCVA) was 20/25. There was a significant improvement in BCVA from 20/160±20/63 at baseline to 20/80±20/50 at the last visit in the 13 successfully treated eyes (P=0.025).

Conclusions: SB can be effective for re-RD after PPV in specific cases.

Background

Treatment of recurrent retinal detachment (re-RD) following vitrectomy (post-gas/air tamponade and post-silicone oil removal) is challenging. Treatment mainly includes scleral buckling (SB) and revision pars plana vitrectomy (PPV) combined with tamponade[1], the latter of which is invasive and a burden both economically and emotionally when compared with SB. The tamponade agent commonly used is silicone oil, and the eyes can easily become oil-dependent. Many studies have reported the outcomes of surgery for re-RD[1-9]; however, there have been no clinical trials evaluating the role of SB to treat re-RD in post-vitrectomy eyes. SB creates an area of contact by bringing the retinal pigment epithelium near the retinal neuroepithelium around the break, by the indentation of the scleral wall to close the break, thus relieving and releasing the vitreous traction and supporting the retinal breaks. SB is less traumatic, and the patient can recover rapidly and comfortably without necessarily being in prone position or only being in the position for a short time if assisted with gas tamponade. This study aimed to assess the anatomical and functional outcomes of SB for re-RD in eyes that have previously undergone one or more PPV.

Methods

The study adheres to the tenets of the Declaration of Helsinki. The surgery was performed after obtaining informed consent from all patients. Data was obtained through a retrospective review of the medical records of patients who underwent SB between November 2016 and November 2019 to treat re-RD after PPV. Only eyes previously diagnosed with rhegmatogenous retinal detachment (RRD) (including macular hole retinal detachment; MHRD) or myopic foveoschisis that underwent PPV at least once were included. Exclusion criteria comprised the following: secondary RRD resulting from trauma, endophthalmitis or diabetic retinopathy; re-RD with silicone oil in situ; re-RD due to macular hole; re-RD with posterior proliferative vitreoretinopathy (PVR) or choroidal detachment; and funnel-shaped re-RD. Fourteen consecutive eyes were included.

All eyes had undergone a complete ocular examination, including slit-lamp examination and binocular indirect ophthalmoscopy. The preoperative data collected included the patients' age and sex, laterality of the eye, lens status, past surgery history, macular status (attached or detached), number and location of breaks, location and extent of re-RD (total or partial in clock hours), axial length, best-corrected visual acuity (BCVA) at baseline, intraocular pressure (IOP) by noncontact tonometry, and duration of re-RD. Surgery details during this time and intraoperative complications were recorded. Postoperative data included length of follow-up, BCVA, IOP, retina status, postoperative complications, and additional surgical procedures.

Surgical Techniques

The surgical procedures were performed under local or general anesthesia by the same surgeon (Dr. Duan). Of the 14 patients, 6 eyes underwent primary retinal repair surgery by Dr. Duan and 8 were referred to Dr. Duan for further management after undergoing one or more unsuccessful surgeries by other surgeons. Indirect ophthalmoscope was used to locate and freeze the retinal breaks. For eyes with more subretinal fluid which influence cryopexy of the breaks, sclerotomy and choroid puncture fluid drainage was performed. A silicon band or/and silicon tire was used. If necessary, the procedure was performed in combination with a vitreous cavity gas injection. Patients who were injected with gas were asked to maintain prone position on the postoperative day, and the position was changed according to the absorption of gas and subretinal fluid.

Statistical Analysis

The Snellen's visual acuity was converted to logarithm of the minimum angle of resolution (logMAR) equivalent for analysis. The logMAR denotations for non-numeric visual acuities were: counting fingers=1.7 logMAR, hand motion=2.0 logMAR, light perception=2.3 logMAR, and no light perception=3.0

logMAR[10]. A P-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using the SPSS statistical software (version 26, IBM SPSS statistics). Continuous variables were expressed as mean±SD, and categorical variables were expressed as individual counts and proportions. Univariate analyses were performed using a paired t-test to determine the association between baseline demographics and outcomes after surgical procedures.

Results

The preoperative characteristics are summarized in Table 1. Of the 14 patients, 12 were male and 2 were female. Patient age ranged from 29 to 74 years (51±15 years). There were 12 right eyes and 2 left eyes. Lens status included 2 (14%) aphakic eyes, 4 (29%) phakic eyes, and 8 (57%) pseudophakic eyes. The first PPV was performed for primary RRD in 11 eyes, macular hole retinal detachment in 2 eyes, and myopic foveoschisis in 1 eye. Three eyes had undergone Lasik surgery before the initial retinal detachment surgery. Only 3 eyes had previously undergone PPV once with gas tamponade, the remaining 11 (79%) eyes underwent 2 to 5 operations, including SB, PPV with gas tamponade, PPV with SB, PPV with silicone oil tamponade, silicone oil removal, silicone oil removal with silicone oil re-tamponade, phacoemulsification with IOL placement, and posterior scleral reinforcement. Of these eyes, 8 (57%) had undergone silicone oil placement and removal before this surgery and 2 had undergone SB before this surgery. The re-RD involved the fovea in 7 (50%) eyes. There was no break detected in 2 eyes, suspected break in 5 eyes, 1 break in 4 eyes, 2 breaks in 2 eyes, and 3 breaks in 1 eye. The break was superior in 4 eyes, inferior in 2 eyes, and both in 1 eye. The RD involved the inferior retina in 11 eyes. The RD extent was limited to a single quadrant in 4 eyes, two quadrants in 5 eyes, three quadrants in 1 eye, and four quadrants in 4 eyes. The axial length ranged from 22.44 mm to 33.17 mm (26.69±3.47 mm). Six eyes had an axial length more than 26 mm. Seven eyes underwent the procedure with gas injection. The preoperative IOP was 6.2~23.9 mmHg (11.2±4.4 mmHg) and the BCVA was 2.0 LogMAR~ 0.1 LogMAR (0.9±0.5 LogMAR, Snellen 20/160±20/63). Retinal detachment recurred 2 weeks to 10 years after the last surgery. The duration of symptoms ranged from 1 day to 2 months.

The surgery details are summarized in Table 2. Seven eyes underwent the procedure with gas injection at the end of the SB. Subretinal drainage was performed in 9 eyes. The retina was reattached on completion of the surgery in all patients. None of the eyes had any intraoperative complications.

The postoperative follow-up interval ranged from 8 months to 36 months (20±7.9 months). Anatomic success was achieved in all 14 patients one month after the surgery. One eye (Case 11) was observed to have excess subretinal fluid the day after the surgery, which gradually got absorbed one month later (Fig.1). Two eyes (Case 12 and Case 13) had re-RD. Case 12 had some subretinal fluid in the posterior region of the previously compressed temporal retina 4 months later. Total retinal reattachment was achieved after vitreous gas injection and laser treatment. Case 13 had some subretinal fluid 2 weeks later and the retina was reattached after vitreous gas injection; however, his condition gradually worsened and he refused retreatment because of poor vision. At the last follow-up, 13 (93%) eyes achieved total retinal attachment and 1 eye had re-RD. The finest BCVA achieved was 20/25 (0.1 LogMAR). There was a statistically significant improvement in the BCVA, from 20/160±20/63 (0.94±0.53 LogMAR) at baseline to 20/80±20/50 (0.57±0.37 LogMAR) at the last visit in the 13 successfully treated eyes (P=0.025). Except for Case 13, (light perception) whose retinal reattachment was unsuccessful, all other eyes maintained or improved their preoperative vision. The postoperative IOP was in the normal range, except in 1 eye (Case 13: 6 mmHg). The mean preoperative IOP of the 13 successful eyes was 12.05 mmHg and mean postoperative IOP was 15.06 mmHg (P=0.115). The follow-up statistics of all patients are summarized in Table 3.

Table 1 Characteristics of all patients in the study

No.	Age	Sex	Eye	AL (mm)	Symptoms Duration	RD extent (quadrant)	Break Number	Break Location	Macular involvement	Lens status	Previous Diagnosis	Previous ocular surgery
1	71	M	R	23.76	1 day	2	o	-	Y	Pseudophakic	MHRD	1. PPV+ILM peeling+silicon oil injection 2. P+I+silicon oil removal
2[a]	46	F	L	26.5	7 days	1	1	2 o'clock	N	Phakic	RRD	1. PPV+laser+silicon oil injection 2. silicon oil removal
3	29	M	R	-	15 days	3	1	1 o'clock	N	Phakic	RRD	1. PPV+laser+silicon oil injection 2. silicon oil removal
4	40	M	R	24.69	2 days	2	0	-	Y	Aphakic	RRD	1. PPV+P+I+laser+air tamponade
5[b]	40	M	R	30.96	2 months	1	1	2 o'clock	N	Pseudophakic	RRD	1. Scleral buckling 2. Encircling band removal+P+I+laser+air tamponade
6[d]	69	M	R	-	1 month	4	0	-	Y	Pseudophakic	RRD	1. PPV+P+I+laser+gas tamponade 2. PPV+laser+silicon oil injection 3. Silicon oil removal
7	54	M	R	23.77	1 month	1	1	6 o'clock	N	Pseudophakic	RRD	1. P+I 2. PPV+cryo+laser+air tamponade
8	60	M	L	22.44	15 days	2	0	-	Y	Pseudophakic	RRD MH*	1. Scleral buckling+exoplant+cryo+PPV+gas tamponade 2. P+I 3. PPV+laser+silicon oil injection 4. Silicon oil removal 5. PPV+ILM peeling+C2F6 tamponade
9	29	M	R	27.56	20 days	2	3	4-6 o'clock	N	Phakic	MHRD	1. PPV+ILM peeling+ silicon oil injection 2. Silicon oil removal
10	53	M	R	33.17	14 days	1	0	-	N	Aphakic	RRD	1. PPV+P+air tamponade
11[c]	45	M	R	29.11	3 days	3	0	-	Y	Pseudophakic	RRD	1. PPV+laser+silicon oil injection 2. Silicon oil removal
12	74	M	R	30.22	7 days	2	0	-	N	Pseudophakic	Foveoschisis MHRD*	1. PPV+P+I+laser+ILMpeeling+C2F6 tamponade 2. Posterior scleral reinforcement 3. PPV+ILM tamping+air tamponade
13[e]	64	M	R	24.21	22 days	4	2	3&11 o'clock	Y	Aphakic	RRD	1. PPV+lensectomy+laser+silicon oil injection 2. Silicon oil removal+retina repair+silicon oil reinjection 3. Silicon oil removal
14	38	F	R	23.91	14 days	4	1	2 o'clock	N	Phakic	RRD FEVR	1. PPV+laser+gas tamponade

M: male, F: female, AL: axial length, MHRD: macular hole retinal detachment, ILM inner limiting membrane, P: phacoemulsification, I:IOL implant, RRD: rhegmatogenous retinal detachment, PPV: pars plana vitrectomy, FEVR: familial exudative vitreoretinopathy

[a] Lasik surgery history before RRD, P+I surgery after scleral buckling and YAG laser capsulotomy later

[b] Lasik surgery history before RRD, cornea punctate opacity

[c] Lasik surgery history before RRD

[d] posterior capsular opacity, cornea limbus is cloudy

[e] superior temporal corneal leukoma

[*] Secondary complication, the reason for last surgery

gas tamponade: If we don't know the exact gas type, we generally referred to as gas tamponade.

Table 2 Surgery details of all patients in the study

No.	Surgery procedures	SRF drainage	Gas/fluid tamponade	Intraoperative complications
1	219 tire+240 encircling+cryo+SRF drainage	Y	N	N
2	219 tire+240 encircling+cryo+paracentesis of anterior chamber	N	N	N
3	219 tire+240 encircling+cryo+SRF drainage+0.3ml SF6 injection	Y	Y 0.3ml C2F6	N
4	219 tire+240 encircling+cryo+SRF drainage	N	N	N
5	posterior scleral enforcement+219 tire+cryo+paracentesis of anterior chamber	N	N	N
6	219 tire+240 encircling+SRF drainage+paracentesis of anterior chamber	Y	Y 1ml 0.9%Nacl	N
7	219 tire+240 encircling+cryo+paracentesis of anterior chamber+IOL suture	N	N	N
8	previous 219 tire removal+new 219 tire+240 encircling+cryo+1ml air injection	N	Y 1ml air	N
9	219 tire+cryo+SRF drainage+0.3ml C2F6 injection	Y	Y 0.3mlC2F6	N
10	219 tire+240 encircling+cryo+0.3ml SF6 injection	N	Y 0.3mlC2F6	N
11	219 tire+240 encircling+cryo+SRF drainage+paracentesis of anterior chamber+0.3ml C2F6 injection	Y	Y 0.3mlC2F6	N
12	219 tire+240 encircling+cryo+SRF drainage+air injection	Y	Y 0.8ml air	N
13	219 tire+240 encircling+cryo+SRF drainage	Y	N	N
14	219 tire+240 encircling+cryo+SRF drainage+air+C3F8	Y	Y 1.5ml 0.9%Nacl+1ml air+0.18ml C3F8	N

SRF subretinal fluid

Table 3 Follow-up statistics of all patients

No.	Immediate Postop retina status	Retina status on the next day	Preop BCVA in LogMAR (Snellen)	BCVA at the last follow-up in LogMAR (Snellen)	Preop IOP (mmHg)	IOP at the last follow-up (mmHg)	Follow-up time(months)	Retina status at the last follow-up
1	reattached	reattached	1.40 (20/500)	1.30 (20/400)	8.0	15.4	36	attached
2	reattached	reattached	1.00 (20/200)	0.50 (20/63)	14.0	10.8	30	attached
3	reattached	reattached	0.20 (20/32)	0.20 (20/32)	8.0	Tn	30	attached
4	reattached	reattached	0.40 (20/50)	0.10 (20/25)	10.0	Tn	23	attached
5	reattached	reattached	0.10 (20/25)	0.10 (20/25)	10.0	15.5	30	attached
6	reattached	reattached	1.40 (20/500)	0.40 (20/50)	10.0	13.0	18	attached
7	reattached	reattached	2.00 (20/2000)	0.20 (20/32)	8.0	13.0	15	attached
8	reattached	reattached	0.70 (20/100)	0.70 (20/100)	13.0	17.0	21	attached
9	reattached	reattached	0.80 (20/125)	0.80 (20/125)	15.0	20.0	19	attached
10	reattached	reattached	0.90 (20/160)	0.90 (20/160)	23.9	13.0	18	attached
11	reattached	detached	1.00 (20/200)	0.50 (20/63)	11.0	13.0	18	attached
12	reattached	reattached	1.00 (20/200)	0.80 (20/125)	10.8	15.0	8	attached
13	reattached	reattached	1.00 (20/200)	2.30 (light perception)	6.2	6.0	16	detached
14	reattached	reattached	1.30 (20/400)	0.90 (20/160)	8.8	20.0	8	attached

Postop: postoperative, Preop: preoperative

Discussion

Causes of retinal re-detachment after PPV include the following: PVR; factors associated with breaks such as ineffective closure of preexisting breaks, large breaks, opening of old breaks formation of new breaks, reopened macular hole, and progressive vitreoretinal traction; incomplete removal of the vitreous base and shaving; inadequate retinal tamponade not adhering to the strict continuous posture; and perisilicone proliferation. The most common cause of recurrent RD is PVR[10]. Contraction of PVR may cause retinal foreshortening, which can exert anteroposterior, perpendicular, and/or circumferential traction on the retina, particularly near the vitreous base[3]. Furthermore, foreshortening of the retina may prevent retinal reattachment. SB can relax the tractional forces on the retina, thus reattaching the retina effectively. All our 14 cases had PVR, and at the last follow-up, 13 of the 14 patients achieved anatomical success, supporting the importance of relaxing the tractional forces when reattaching the retina.

In a review[11], Edwin and Robert analyzed the continued role of SB in the vitrectomy era. They found that significant skill and practice is required to correctly place the SB elements with the desired indentation to support the retinal tears and to drain the subretinal fluid without complications. In our research, the RD were not primary retinal detachment, but re-RD with PVR. Nevertheless, we had a high success rate. This could be attributed to the surgeon's experience and careful patient selection. Generally, the criteria for case selection are as follows: (1) The (probable) retinal tear is on the periphery; (2) There is no obvious proliferative traction in the posterior retina; and (3) The height of RD is low. Patients with funnel-shaped RD cannot undergo this surgery.

RD in post-vitrectomy eyes can progress rapidly, which can easily lead to PVR. Furthermore, if another PPV is performed to attach the retina, silicone oil may be used, often causing the eye to become oil-dependent. Furthermore, the presence of silicone oil does not guarantee retinal reattachment. The recurrence rate of RD in silicone-oil filled eyes is 22%[12]. The postoperative complications associated with using silicone oil occur both in the anterior and posterior segments, including keratopathy, cataract, glaucoma, silicone oil toxicity in the retina[12, 13]. The longer the silicone oil remains in the eye, the more complications arise. Some authors have reported extraocular extension of silicone oil into the brain 15 months after silicone oil tamponade in the eye[14, 15]. The risk of re-RD is 34% after removal of silicone oil[6]. It is thus important to study the outcomes of other interventions to understand whether performing repeated vitrectomy on patients with a history of failed surgeries is worthwhile. Our research on re-RD in post-vitrectomy eyes with prior RRD demonstrated the benefits of SB.

Twelve out of 14 patients (86%) achieved anatomical success after one operation and 13 out of 14 patients (93%) achieved final anatomical success, which is comparable with previous re-vitrectomy + retinectomy + gas or silicone oil tamponade reports that showed a reattachment rate of 60% to 90% [2, 3, 8, 10]. The inability to detect retinal breaks in a RRD has been reported to be associated with a poor prognosis[16]. In our patients, no clear breaks were detected in 7 eyes preoperatively. Six of the 7 eyes were pseudophakic and the remaining one eye was aphakic. Five of the 7 eyes had suspicious holes and 2 eyes had no visible break during the operation; nevertheless, retinal reattachment was successful in all these cases, which indicated that re-RD without detecting a break is not a contraindication for SB. The reasons why breaks cannot be detected are as follows: the IOL occludes some small breaks, the break is too small to be found, the RD is too high and the break is hidden in the PVR, or there is no break present.

Despite having undergone a mean of 3.29 surgeries at the last visit, 5 (36%) of our 14 patients still had a final BCVA≥0.4 LogMAR (Snellen 20/50), which is also promising compared with previous reports[9, 10, 17]. Macular involvement with RD is a known risk factor for a limited visual outcome[5, 16]. In our cases, 7 patients had macula-on retinal detachment. One eye maintained the preoperative vision, 5 eyes had improved vision, with the best BCVA reaching 0.1 LogMAR (Snellen 20/25), and one eye had decreased vision because of failure to reattach the retina.

The advantages of SB for treating recurrent RD after PPV are mainly as follows: (1) It alleviates damage to the eye using minimal surgery compared with PPV. (2) It does not interfere with the intraocular tissue (SB is an external operation), which can reduce irritation to the posterior retina, thus protecting the macula to some extent and improving vision recovery after operation. (3) Patients need to be in a prone position for no or a short time after operation if combined with gas injection, thus relieving the patient’s suffering. (4) Repeated PPV procedures are inherently more expensive than SB, and it increases difficulty in operating and usually leads to silicone oil dependent eyes, causing both economical and emotional burden. Moreover, the presence of silicone oil does not guarantee correct retinal positioning, with an RD recurrence rate of 22%[12].

The disadvantages of SB for treating recurrent RD after PPV are mainly as follows: (1) SB greatly differs from PPV, and there is a significant learning curve. Experience with many cases is required to accurately select the most effective elements[11]. Therefore, both proficiency in indirect ophthalmoscopy and caution when performing SB procedures are necessary. Experience and correct technique to treat complications are necessary. (2) Ocular surface inflammation is more severe after SB, but it quickly recovers. (3) It is more likely to cause high IOP and anterior segment ischemia syndrome compared with PPV. Though the chances are low, irreversible visual impairment can be damaging. (4) The buckle material can cause some changes in the eyeball structure, inducing myopia and astigmatism[18].

Improvements in the instruments used for vitrectomy and the introduction of 25-gauge vitrectomy has decreased the necessity of suturing. Hence, it may have increased the surgeons’ preference to perform vitrectomy over SB[18]. Nevertheless, multiple PPVs may not always be the best strategy for patients, and SB may be more beneficial.

Conclusions

To the best of our knowledge, this is the first report to demonstrate the effectiveness of SB for re-RD in specific eyes after PPV.

There are some limitations to our study. Firstly, the sample size was small. Furthermore, at the end of the SB surgery, gas (air or C_2F_6) was injected in some eyes, which may have affected the evaluation of SB surgery alone. Nevertheless, the preliminary results of our study are promising, and clinicians should consider whether SB is feasible instead of repeated vitrectomy for patients with a history of failed surgeries. However, further prospective clinical trials with a larger number of cases are necessary for a full evaluation of the effect of SB, and for determining the optimal surgical procedure for the treatment of re-RD after PPV.

Abbreviations

SB: scleral buckling; re-RD: recurrent retinal detachment; PPV: pars plana vitrectomy; BCVA: best-corrected visual acuity; RRD: rhegmatogenous retinal detachment; MHRD: macular hole retinal detachment; logMAR: logarithm of the minimum angle of resolution; SRF: subretinal fluid

Declarations

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Authors' contributions

JXB and XJZ performed the initial clinical database search, identified confirmed cases of re-RD, collected all images and generated descriptive statistics as presented. JXB produced the first draft of the manuscript and figures. XYP, ALD and JXB contributed to the study concept and design, reviewed statistical analysis and edited the manuscript, contributing to the final version sent for approval. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analysed during this study are included in this published article. The datasets used during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

We adhered to the tenets of the Declaration of Helsinki. Ethics approval was obtained from the the ethics committee of Beijing Tongren hospital. All participants involved were informed of the purpose of this study and a written consent was obtained from themselves.

Consent for publication

Written informed consent was obtained from all patients for the publication of this report and any accompanying images. A copy of the written consent is available for review by the editor of this journal.

Competing interests

No conflict of interest exits in the submission of this manuscript, and this manuscript was approved by all authors for publication. We declare that the work described was original research that has not been published previously and is not under consideration for publication elsewhere, in whole or in part.

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Figures

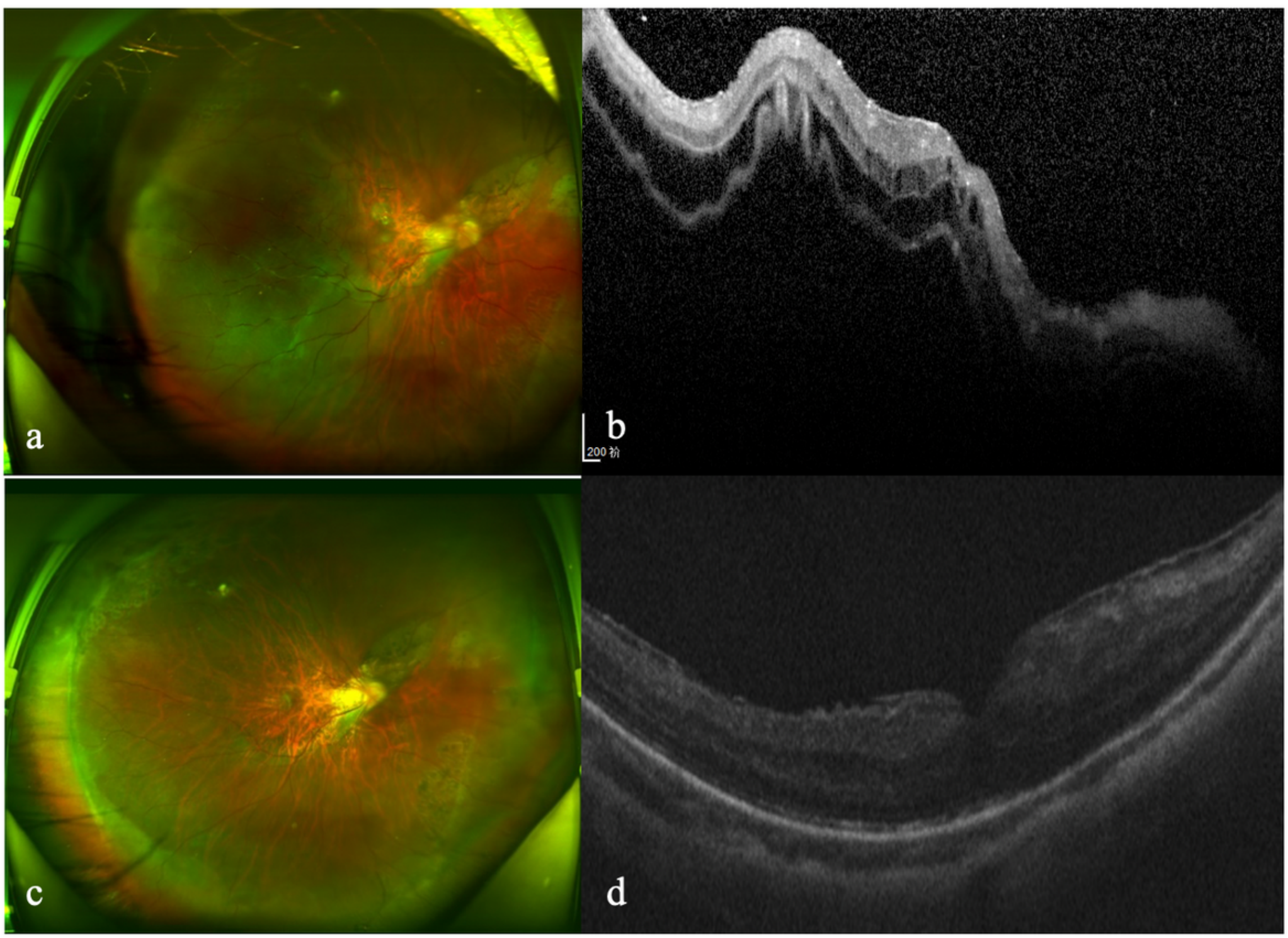
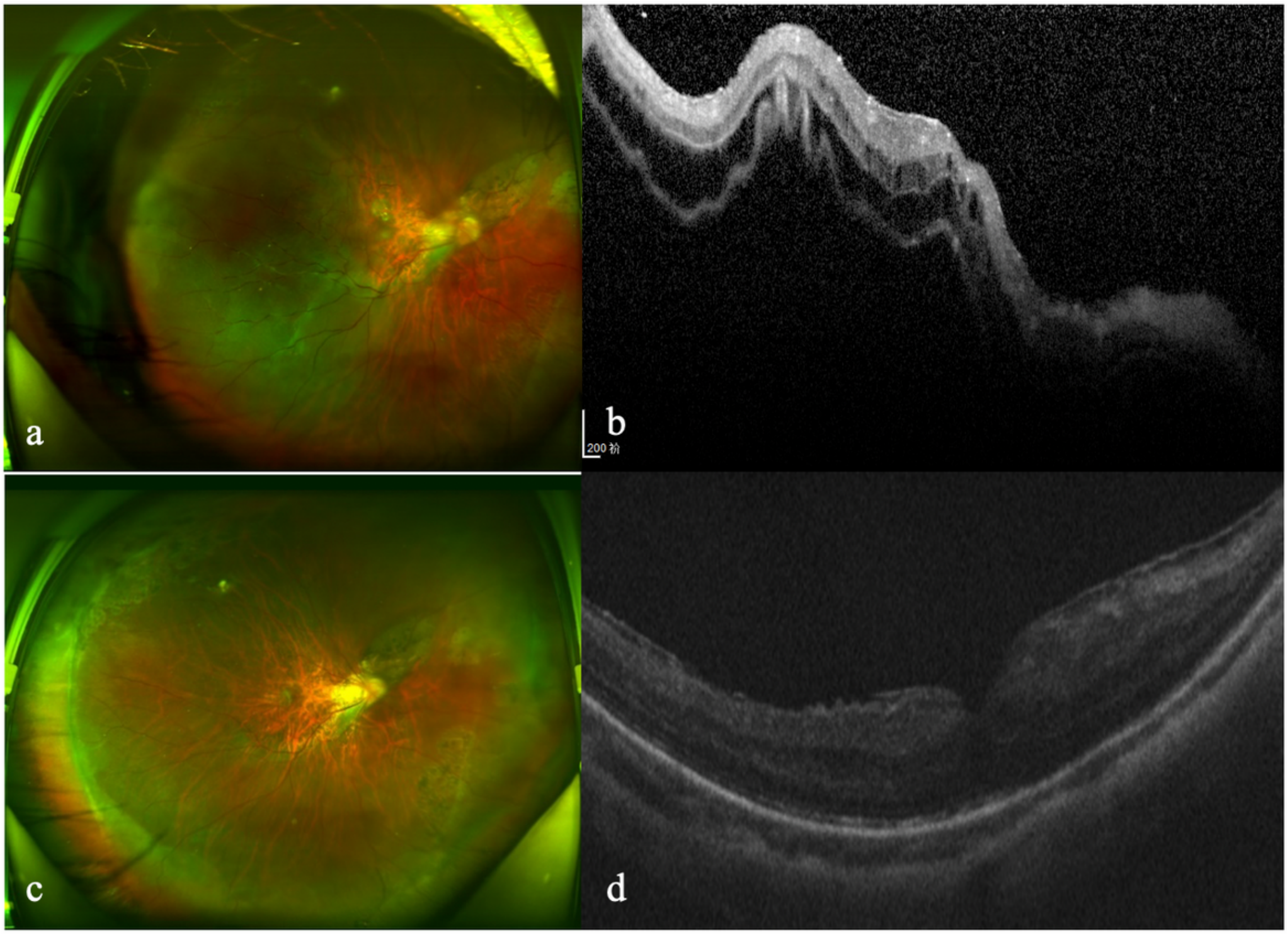


Figure 1

Changes of Case 11 before and after surgery. Fudus photography before SB surgery(a). OCT before SB surgery (b). Fudus photography 2 months after SB surgery (c). OCT 2 months after SB surgery (d).



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