

Retinectomy vs vitrectomy combined with scleral buckling in repair of posterior segment open-globe injuries with retinal incarceration

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Abstract

Purpose To evaluate the anatomic and functional outcome of pars plana vitrectomy (PPV) combined with scleral buckling (SB) vs retinectomy in treating posterior segment open-globe injuries with retinal incarceration.

Methods Patients (38 eyes) with posterior segment open-globe injuries and retinal incarceration were identified, and they underwent either PPV combined with SB (PPV+SB, $n = 19$) or retinectomy ($n = 19$).

The two groups were matched in the following categories: the severity of injury (including wound length), the location of the incarceration site and the presence of retinal detachment. Anatomic reattachment of the retina and best-corrected visual acuity (BCVA) were measured at the time of 12 months after operation.

Results At 12 months after operation, the PPV+SB group demonstrated a better anatomic retinal attachment rate (84.2% vs 68.4%, $P = 0.252$) and BCVA (73.7% vs 47.4%, $P = 0.247$) compared with the retinectomy group, however, the differences failed to reach statistical significance. Compared with the PPV+SB group, the retinectomy group had significantly higher rates of hemorrhage (47.4% vs 15.8%, $P = 0.036$), inflammation (42.1% vs 10.5%, $P = 0.027$), and a lower intraocular pressure (IOP, 9.8 ± 3.1 vs 13.6 ± 4.1 mmHg, $P = 0.002$) after silicone oil (SO) removal.

Conclusions For patients with posterior segment open-globe injuries and retinal incarceration, PPV and SB treatments resulted in a better anatomic and functional outcome and less post-operation complications compared with the retinectomy.

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Introduction

Open-globe injuries that affect the posterior segment of the eye may result in retinal tearing at the site of injury or an incarceration of vitreous, retina and choroid. If the retina is incarcerated, a retinectomy may be necessary to avoid the dragging of the retina and tractional or secondary rhegmatogenous retinal detachment.¹ Another surgical approach is to use the combination of pars plana vitrectomy (PPV) with encircling scleral buckling (SB), this method could relieve the traction on the retinal incarcerated site and support the retinal breaks.^{2,3}

In three large retrospective studies, prophylactic SB placement at the time of vitrectomy for posterior segment trauma was associated with a lower rate of subsequent retinal detachment.^{2–4} The SB placement within 2 weeks following a severe ocular injury appeared to reduce the rate of post-traumatic complications.⁵ However, these studies only compared the eyes with or without SB placement at the time of PPV. Little information is currently available to compare the anatomic outcome of retinectomy and the combined approach of SB and PPV in treating posterior segment open-globe injuries with retina incarceration. In this study, we conducted a retrospective matched case-control study to evaluate the two different surgical approaches, retinectomy vs PPV combined with SB, on the outcome of the patients following open-globe injuries. The prognostic

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factors affecting anatomic success in these patients were also determined.

Materials and methods

Patients

This study was performed in accordance of the Declaration of Helsinki of the World Medical Association. All the cases ($n=38$) were selected from the practice of two vitreoretinal surgeons over a 5-year period. Surgeon A performed 12 cases of retinectomy and 14 cases of PPV+SB, respectively. Surgeon B performed seven cases of retinectomy and five cases of PPV+SB, respectively. All the patients were diagnosed with posterior segment open-globe injuries with retinal incarceration and vitreous hemorrhage and/or shallow retinal detachment from March 2008 and June 2013. The early cases (19 eyes, from March 2008 to June 2011) underwent retinectomy, and the later cases (19 eyes, from July 2011 to June 2013) underwent the combination of SB and PPV. The surgery was performed within 10–21 days following the closure of primary corneal/scleral lacerations. Patients who met any of the following criteria were excluded from this study: a zone 1 or zone 2 injury only (according to the open-globe injury classification system), no light perception, no relative afferent pupillary defect (+), no retinal detachment occurring immediately after the eye trauma, severe retinal detachment or presence of proliferative vitreoretinopathy (grade C), an intraocular foreign body or endophthalmitis, a vitrectomy or a SB performed at the time of primary open-globe repair, or follow-up <6 months. Patients treated with SB and PPV and the patients treated with retinectomy were matched in the severity of injury (including wound length), the location of the incarceration site, and the presence of retinal detachment.

Classification of eye injuries: injuries were classified as penetration, perforation, or rupture according to Kuhn *et al.*⁶ The location of the injury was noted and the severity of injury was classified according to Eagling as grades 3–4⁷ (Grade 3: posterior segment injury with vitreous loss; Grade 4: extensive anterior and posterior injury). Data regarding the anatomic and functional status of the eye before initial repair of the wound were obtained from the initial examination or at the time of surgery. Information collected from each case included age, gender, initial visual acuity, preoperative intraocular pressure (IOP), interval between the closure of primary corneal/scleral lacerations and PPV, type and severity of injury, location of the incarceration site, wound length, presence of retinal detachment, surgical procedures, retinal reattachment rate, final visual outcomes, postoperative IOP, and complications. Postoperative hemorrhage was defined as the bleeding in the anterior chamber after operation; it causes difficulty to

observe the fundus. Postoperative inflammation was defined as the opacification in the anterior chamber because of the increased proteins and cells in the aqueous humor; it also makes it hard to exam the fundus.

Vitrectomy

The vitrectomy technique entailed a 20-gauge/23-gauge 3-port pars plana approach involving a sclerotomy located 3 to 3.5 mm posterior to the limbus. Phacoemulsification or lensectomy was performed before the PPV procedure in the cases with traumatic cataract. The entire capsule was removed and no intraocular lens implantation was performed. The core vitrectomy and peripheral vitreous dissection were performed. The radical anterior vitreous base dissection with 360° scleral depression was performed in the eyes with lens removed. A dose of 0.1 ml/4 mg triamcinolone acetonide aqueous suspension (40 mg/1.0 ml suspension, Erba Co., Via Licinio, Italy) was injected to the posterior pole of the eye for visualizing the residual cortical vitreous. If PVD was not present, then the posterior hyaloid face was separated from the optic disk and removed by using a vitreous cutter (controlled suction up to 150 mm Hg) near optic disk or by using a membrane pick. The air-fluid exchange was performed, whereas the subretinal fluid was drained using a soft-tipped cannula over the retinal tear. Retinectomy was performed with scissors or the high-speed vitreous cutter after the application of full-thickness retinal cautery. The retinectomy we performed included both the incarceration site and the surrounding area. If the incarceration site was located superiorly, then retinectomy was performed around the incarceration site. If the incarceration site was located inferiorly, then retinectomy was performed by removing the inferior peripheral retina including the incarceration site. The retina was reattached with perfluorocarbon liquid or an air-fluid exchange combined with internal drainage of subretinal fluid. A triple concentric pattern of endolaser was applied around the retinectomy. Silicone oil (SO, Oxane 5700, Bausch & Lomb Incorporated, Rochester, UK) tamponade was performed at the end of the surgery.

SB combined with PPV

In patients treated with SB combined with PPV, a 2.5-mm encircling solid silicone explant was placed with four scleral fixation sutures in the middle of each oblique quadrant, and a 4.5–7 mm silicone strip was placed at the tear and the incarceration site after PPV and SO tamponade was performed. Follow-up examinations were performed at 1 week, 1, 3, and 6 months after surgery. SO was removed 6–12 months after surgery for patients with retinal attachment.

Statistical Analysis

Statistical analysis was performed using SPSS statistical software (version 11.5; SPSS, Chicago, IL, USA). Continuous variables were expressed as mean ± SD, and categorical variables were expressed as individual counts and proportions. The Snellen BCVA was converted into logarithm of minimum angle of resolution (logMAR) units for analysis. The following logMAR conversions were used for the vision worse than 20/400: counting fingers = 2.00 logMAR units, hand motion = 2.30 logMAR units, light perception = 2.60 logMAR units. Continuous variables were analyzed by using a *t*-test. Ordinal variables were analyzed using a χ^2 -test, and the Fisher’s exact test, as appropriate. The critical value of significance was set at $P < 0.05$ for all tests.

Results

For the two treatment groups, 19 patients underwent surgery of combination of PPV and SB (PPV+SB) and 19 patients had retinectomy. The two groups were matched in the following three categories: the severity of injury (including wound length), the location of the incarceration site, and presence of retinal detachment ($P = 1.000$; Table 1). In addition, the two groups were similar in other potential prognostic factors including age, sex, types of injury, initial visual grade, preoperative IOP, interval between the closing of primary corneal/scleral lacerations and PPV (Table 2).

The mean follow-up was 17 months (range 12–27 months) for the PPV+SB group, and 16 months (range 12–26 months) for the retinectomy group. SO was removed in 17 eyes of PPV+SB group (89.5%) and 16 eyes of retinectomy group (84.2%), respectively, at 4–6 months after the operation. The retina in 14 of the 17 eyes (82.4%) in the PPV+SB

Table 1 Matched patient baseline characteristics in different groups

	PPV+ SB (19 eyes)	Retinectomy (19 eyes)	P-value
Severity of injury			1.000
Grade 3 (wound length < 10 mm)	12	12	
Grade 3 (wound length ≥ 10 mm)	3	3	
Grade 4 (wound length < 10 mm)	3	3	
Grade 4 (wound length ≥ 10 mm)	1	1	
Location of the incarceration site			1.000
superior	12	12	
inferior	7	7	
Presence of retinal detachment	17	17	1.000

Abbreviations: PPV, pars plana vitrectomy; SB, scleral buckling. Grade 3: posterior segment injury with vitreous loss; Grade 4: extensive anterior and posterior injury.

group and 9 of the 16 eyes (56.2%) in the retinectomy group remained attached for a mean follow-up time of 16 months (range 9–21 months) after SO removal. Three eyes in the PPV+SB group (15.8%) and four in the retinectomy group (21.1%) had reoperation immediately after SO removal, and two eyes in the retinectomy group (10.5%) needed reoperation 1–2 months after SO removal. Two patients in the PPV+SB group (10.5%) and 3 patients in the retinectomy group (15.8%) refused to have SO removal at 6 months after the operation, SO was left in place and no complications were found in these patients at the last follow-up. As seen in Table 3, overall, 16 eyes in the PPV+SB group (84.2%) and 13 eyes in the retinectomy group (68.4%) attained anatomic retinal attachment; there was no significant difference between the two groups ($P = 0.252$). BCVA was improved in 14 eyes (73.7%) in the PPV+SB group and 9 eyes (47.4%) in the retinectomy group, respectively. The improvement rate in the PPV+SB group trended higher than the retinectomy group but the significant differences was not reached ($P = 0.247$). BCVA was worsened in 2 eyes in the PPV+SB group (10.5%) and 4 eyes in the retinectomy group (21.1%), respectively, and these eyes never achieved retinal reattachment. One eye in

Table 2 Unmatched patient baseline characteristics in different groups

	PPV+SB (19 eyes)	Retinectomy (19 eyes)	P-value
Age (years)			0.598
Range	23–54	16–61	
Mean ± SD	38.1 ± 9.4	36.1 ± 12.9	
Gender			0.693
Male	14	16	
Female	5	3	
The type of injury (eyes)			0.768
Penetration	10	9	
Perforation	5	7	
Rupture	4	2	
Preoperative VA (LogMAR units)			0.579
Range	0.7–2.6	0.7–2.6	
Mean ± SD	1.4 ± 0.6	1.3 ± 0.5	
Preoperative IOP (mm Hg)			0.779
Range	7–22	8–25	
Mean ± SD	13.8 ± 4.6	14.2 ± 4.5	
Time (days)			0.674
Range	10–21	11–21	
Mean ± SD	15.4 ± 3.1	15.8 ± 3.0	

Abbreviations: PPV, pars plana vitrectomy; SB, scleral buckling; VA, Visual acuity. Time, interval between closure of corneal/scleral lacerations and PPV.

Table 3 Postoperative clinical characteristics in different groups

	PPV+SB (19 eyes)	Retinectomy (19 eyes)	P-value
Retinal reattachment rate	16 (84.2%)	13 (68.4%)	0.252
Final BCVA (LogMAR units)			
Range	0.5–2.6	0.5–2.6	0.247
Mean \pm SD	1.1 \pm 0.5	1.2 \pm 0.6	
Improved	14 (73.7%)	9 (47.4%)	
Maintained	2 (10.5%)	4 (21.1%)	
Worsened	3 (15.8%)	6 (31.6%)	
SO removal	17 (89.5%)	16 (84.2%)	0.631
Postoperative complications			
Glaucoma	5 (26.3%)	3 (15.8%)	0.426
Hemorrhage	3 (15.8%)	9 (47.4%)	0.036
Inflammation	2 (10.5%)	8 (42.1%)	0.027
IOP after SO removal (mm Hg)	13.6 \pm 4.1	9.8 \pm 3.1	0.002

Abbreviations: BCVA, best-corrected visual acuity; IOP, intraocular pressure; PPV, pars plana vitrectomy; SB, scleral buckling; SO, Silicone oil.

the PPV+SB group (5.3%) and two eyes in the retinectomy group (10.5%) had a visually significant cataract (Table 3).

Among the 38 phakic eyes in the 2 groups, traumatic cataract were removed in 3 eyes (15.8%) in the PPV+SB group and 2 eyes (10.5%) in the retinectomy group, respectively, by phacoemulsification or lensectomy during the operation. For the other 33 eyes (PPV+SB: $n = 16$; Retinectomy: $n = 17$) with lens preserved after operation, 3 eyes in the PPV+SB group (18.8%) and 4 eyes in the retinectomy group (23.5%) developed cataract affecting vision and later required cataract surgery during the course of the follow-up (7 to 20 months, mean 12.2 months).

Five eyes in the PPV+SB group (26.3%) and 3 eyes in the retinectomy group (15.8%) developed increased intraocular pressure, requiring more than one anti-glaucoma medication during the postoperative period. Compared with the PPV+SB group, the retinectomy group had significantly higher rates of hemorrhage (47.4% vs 15.8%, $P = 0.036$) and inflammation (42.1% vs 10.5%, $P = 0.027$) during first week of the postoperative period, and the retinectomy group had a significantly lower IOP compared with the PPV+SB group (9.8 ± 3.1 vs 13.6 ± 4.1 mm Hg, $P = 0.002$) after SO removal (Table 3).

Discussion

The posterior open-globe injury often results in vitreous loss and vitreoretinal traction. It can also tear the retina at the site of injury or may produce an incarceration of vitreous, retina, and choroid. It may also cause progressive scarring and the shortening the vitreous and retina, which can produce tears, often in the incarceration site.¹ Corneal or scleral lacerations require a primary repair immediately, and PPV is usually needed for these eyes. The timing for the vitrectomy is a balance between allowing the settling of immediate inflammation and

engorgement of the eye, and avoiding the risk of developing of a closed funnel retinal detachment from PVR.¹ A PPV at 10–14 days after trauma is suggested.^{8,9}

The advantage of vitrectomy in treating posterior open-globe injuries is the removal of the blood and other pathologic stimulants of wound healing response, including the vitreous scaffold, the proliferating cells and serum products.¹⁰ If the retina is incarcerated, then a retinectomy may be necessary to avoid the dragging of the retina and tractional or secondary rhegmatogenous retinal detachment.¹ However, not all posterior open-globe injuries with incarceration will progress, and the progression should be monitored, so the use of a prophylactic SB combined with PPV for these eyes may be reasonable. The two main reasons for prophylactic circumferential buckle are the difficulty in visualizing the peripheral retina in a traumatized eye with residual vitreous hemorrhage^{2,3} and the desire to support the incarceration site and vitreous base against the possibility of later vitreous traction. In the present study, we compared the combined approach of PPV and SB placement and retinectomy in treating posterior open-globe injuries, patients who underwent SB and PPV demonstrated more significant improvement in anatomic and functional outcome compared with the retinectomy group, as shown by a better anatomic retinal attachment rate (84.2% vs 68.4%) and a better BCVA improvement rate (73.7% vs 47.4%), although the significant difference was not reached ($P = 0.252$). Eyes with SB and PPV had significantly lower rates of postoperative hemorrhage and inflammation compared with the retinectomy group.

It is difficult to standardize the open-globe injuries because of the individual variability from patient to patient. In the present study, we attempted to categorize the patients using several markers such as location and length of the wound, the grade of injury and the wound length (severity of injury). These are usually strong predictors for the outcome of the open eye injuries.^{11,12} In this study, the two treatment groups were matched in the severity of injury, location of the incarceration site, and the presence of retinal detachment. The retinal detachment initiates and propagates in the open-eye injury because of the PVR later on, and all of the retinal detachments are shallow detachments without severe PVR (grade C). We excluded those eyes with relative afferent papillary defect and retinal detachment occurring immediately after the eye trauma, since previous studies have shown that both conditions could lead to a poor prognosis.^{11–13} In addition, other patient characteristics were also similar between the two treatment groups, including age, type of injury, initial visual grade, preoperative IOP, interval between the closure of primary corneal/scleral lacerations and PPV.

However, the present study has some important limitations. First, this study had a relatively small sample size; Second, the patients were from two academic medical centers in different geographic locations, and were treated by different surgeons. Although both institutions have similar surgical training program for residents and fellows in eye trauma, there may be differences in the patient population and/or treatment regimens. Finally, although the two treatment groups were matched in three important prognostic determinants, there may be other predictors affecting the outcome, including the type of injury, initial visual grade, preoperative IOP, vitreous hemorrhage, cataract, interval between the closure of corneal/scleral lacerations and PPV. These factors were not matched owing to the limited number of available patients and controls.

In conclusion, this study suggests that for the treatment of posterior segment open-globe injuries with retina incarceration, SB combined with PPV may have a better final visual and anatomic outcome compared with the retinectomy. In addition, treatment of SB and PPV may cause fewer complications than the retinectomy. Given the large number of patients at a risk of visual impairment due to ocular trauma, a randomized clinical trial may be necessary to confirm our findings.

Summary

What was known before

- Open globe injuries that affect the posterior segment of the eye may result in retinal tearing at the site of injury or an incarceration of vitreous, retina and choroid.
- If the retina is incarcerated, a retinectomy may be necessary to avoid the dragging of the retina and tractional or secondary rhegmatogenous retinal detachment.
- Another surgical approach is to use the combination of pars plana vitrectomy (PPV) with encircling scleral buckling (SB), this method could relieve the traction on the retinal incarcerated site and support the retinal breaks.

What this study adds

- In this study, we conducted a retrospective matched case-control study to evaluate the two different surgical approaches, retinectomy vs PPV combined with SB, on the outcome of the patients following open-globe injuries.
- The prognostic factors affecting anatomic success in these patients were also determined.

Conflict of interest

The authors declare no conflict of interest.

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