

Combined treatment of minimally invasive 23-G vitrectomy and chandelier for superior bullous rhegmatogenous retinal detachment

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Abstract. – **OBJECTIVE:** To investigate the clinical efficacy of minimally invasive 23G vitrectomy combined with chandelier for the treatment of superior bullous rhegmatogenous retinal detachment (SBRRD).

PATIENTS AND METHODS: A retrospective case series study of 50 patients with SBRRD was conducted. Each of these patients received minimally invasive 23G vitrectomy in one of their eye. A trocar was indwelled with two-step 23-G incision, and the chandelier was inserted in the inferior 6 o'clock pars plana. The tear was closed with 23-G vitrectomy combined with endolaser photocoagulation and infused with perfluoropropane (C3F8) under non-contact wide-angle lens. Postoperative follow-up ranged from 5-49 months (mean 23.9 ± 1.3 months). Intraoperative and postoperative complications, postoperative conjunctival hyperemia, eye irritation signs and inflammation reactions, retinal anatomic reduction rate, best corrected visual acuity (BCVA) and intraocular pressure (IOP) changes were analyzed.

RESULTS: The intraoperative scleral incision leakage required 17 sutures (34%). No complications, such as iatrogenic retinal breaks and hemorrhage occurred. The postoperative conjunctival hyperemia, eye irritation signs and inflammation reactions were mild. Transient low IOP occurred in one eye (2%) on the first day postoperatively and recovered on the next day. Transient low IOP occurred in eyes of 16 subjects (32%) and recovered after lowering IOP therapy within an average of 4 days. No complications, such as hemorrhage, effusion, choroidal detachment and endophthalmitis were observed. Forty-nine subjects (98%) had retinal reattachment in their eyes after a single surgery, and 100% eyes showed final retinal reattachment. The preoperative and postoperative BCVAs were 4.61 ± 0.19 and 4.70 ± 0.19 , respectively, in 8 patients without detached macula, and the difference was not statistically significant ($t = 2.20$, $p > 0.05$).

CONCLUSIONS: Minimally invasive 23G vitrectomy combined with chandelier is a safe and

effective surgical approach for the treatment of SBRRD.

Key Words:

23-G vitrectomy, Chandelier, Superior tear, Retinal detachment.

Introduction

Rhegmatogenous retinal detachment is a common severe blinding oculopathy. Bullous rhegmatogenous retinal detachment (SBRRD) typically occurs in the patients with medium-high myopia, usually complicated with acute Posterior Vitreous Detachment (PVD). Retinal detachment tends to involve macula lutea, and causes acute impaired visual acuity. Therefore, the patient can be identified and treated timely. Due to earlier diagnosis, the Proliferative Vitreous Retinopathy (PVR) in these patients is usually mild, thus making it difficult for ophthalmologists to decide between scleral buckling and vitrectomy. The safety and efficacy of minimally invasive 23-G vitrectomy combined with chandelier for the treatment of SBRRD has not been reported so far. In this study, we present preliminary results of a retrospective analysis of a series of consecutive cases, and evaluation of safety and efficacy of this approach for the treatment of SBRRD.

Patients and Methods

Patients

A series of consecutive cases of SBRRD received 23-G vitrectomy from Dec. 2007 to Dec. 2010 but patients with history of ocular trauma, vitrectomy, PVR C and above were excluded. A total of 50 patients (50 eyes) were included in this study, with 29 males (29 eyes) and 21 fe-

males (21 eyes). The age range was 25-78 years, with a mean age of 50.8 ± 1.2 years. The mean course of retinal detachment at presentation was 4-180 days, with a mean course of 28.6 ± 3.1 days. Preoperatively, 42 eyes showed a retinal detachment that involved the macula lutea, but 8 eyes did not involve the macula lutea, as well as 2 eyes had an intraocular lens and 14 eyes had a cataract. All tears were located in the 10-2 o'clock orientation, including 38 eyes of horse-shoe tear, 8 eyes of round hole, 4 eyes of horse-shoe tear and round hole; 36 eyes with PVR A and 14 eyes with PVR B.

Surgical Methods

All patients signed the informed consent form before surgery. All surgeries were performed by the same surgeon. A two-step incision was performed after posterior eyeball anesthesia. A tunnel was made by stabbing into sclera with a 23G stab blade at a 30°-angled incision via bulbar conjunctiva 3.5 mm from infratemporal, supratemporal and supernasal corneal limbus. The trocar was closely inserted next to the back of stab blade and along the tunnel into sclera obliquely, and then stabbed into the eye vertically. The perfusion cannula was indwelled in the infratemporal incision and stabbed vertically in the inferior 6 o'clock pars plana with a 2 ml syringe needle and then the chandelier was inserted (see Figure 1A) bimanually (when a surgeon performs resection of peripheral vitreous body and peripheral fundus laser, he could press the sclera with one hand and perform the procedures with the other hand). Patients with complication of cataract first received phacoemulsification via the superior transparent corneal tunnel incision, and then 3-channel 23-G vitrectomy. The surgery was performed under non-contact wide-angle lens. The central and peripheral vitreous bodies were resected with Accurus 800 Vitrectomy Instrument (3D model, Alcon Laboratories Inc., Johns Creek, GA, USA) (higher the negative pressure: lower the cutting rate, and vice versa). The cutting rate of central vitreous body was set at 1800 times/min, and the negative pressure at 400 mmHg; the cutting rate of detached retina surface at 2500 times/min, and the negative pressure was set at 100 mmHg (see Figure 1B). Thirty-one eyes with complete PVD, 17 eyes with partial PVD and 2 eyes with no PVD were examined during the surgery. After artificial PVD, infused with perfluorodecalin into vitreous cavity to discharge subretinal fluid, it flattened the retina,

closed the retinal tear with laser (Figure 1C), performed fluid-air exchange, removed the supratemporal and supernasal trocar, and the incision was closed with cotton swab. Viscoelastic was infused into the incision in case of a leakage. If leakage still occurred in the incision, multilayer suture once in the scleral conjunctiva incision with 8-0 suture was used and the trocar connected to the infusion tube was removed (see Figure 1D). C_3F_8 (1 ml) was infused via pars plana for filling. When the IOP was low, additional air was infused in the vitreous chamber, and a simple applanation tonometer was placed horizontally on the corneal surface. The IOP was adjusted by supplementing or exhausting the air in vitreous chamber so that the watermark on cornea could overlap the outer ring in the bottom of tonometer, with an IOP of 15 mmHg (Figure 1E). C_3F_8 could be completely absorbed within approximately 40 days. Two weeks of prone position or semi-sitting position was required postoperatively.

Observational Indicators

Postoperative ocular hyperemia, corneal transparency and anterior chamber inflammation were observed with a slit lamp. The vitreous body and retinal reattachment were inspected with Hruby preset lens. The preoperative and postoperative IOPs were measured with a non-contact tonometer. The best corrected visual acuity (BCVA) was recorded and translated into the equivalent of logarithmic visual acuity chart (5-grade notation).

Statistical Analysis

The SPSS13.0 statistical software package (SPSS Inc., Chicago, IL, USA) was used for data analysis. The *t*-test was used to compare the mean of self-paired samples for the vision change before and after surgery. A difference of $p < 0.05$ was considered statistically significant.

Results

Complications

The intraoperative leakage in the scleral incision required 17 sutures (34%), but no complications such as, iatrogenic retinal breaks and hemorrhage occurred. One eye (2%) had transient low IOP on day 1 postoperatively, which recovered after pressure dressing on the next day. Sixteen eyes (32%) had transient increased IOP 1-8 days postoperatively, with a mean of 3.1 ± 2.6

days. Six eyes receiving medication via paracentesis of the anterior chamber and 10 eyes receiving lowing-IOP medication recovered 3-16 days postoperatively, with a mean of 7.4 ± 4.5 days. No postoperative complications occurred, such as choroidal detachment and endophthalmitis. At the end of follow-up, 2 eyes (4%) had secondary epiretinal membrane, 7 eyes (14%) had increased eye lens nucleus density, including 3 eyes received cataract extraction within 9, 11 and 29 months. At the last follow-up, slight conjunctiva scars could be seen in each of 2 eyes out of 50 eyes, with conjunctiva scars in 3 sites of one eye, the remaining conjunctivas were smooth, with normal vascular distribution.

Postoperative Responses

Nine eyes (18%) had mild conjunctival hyperemia, 35 eyes (70%) had moderate conjunctival hyperemia, 6 eyes (12%) had severe conjunctival hyperemia on day 1 postoperatively; 1 week after surgery, 38 eyes (76%) had mild conjunctival hyperemia, 12 eyes (24%) had moderate conjunctival hyperemia, the moderate conjunctival hyper-

emia subsided after approximately 2 weeks, with smooth surface (Figure 1F); 21 eyes (42%) had positive Tyndall phenomenon in the anterior chamber on day 1 postoperatively, which resolved within a mean of 3 days postoperatively; 7 patients with corneal edema (including 6 patients due to high IOP) recovered within a mean of 4 days postoperatively.

Anatomical Reduction

Forty-nine eyes (98%) had retinal reattachment after the first surgery, 1 eye had a new tear in the temporal retina on day 7 postoperatively, and retinal reattachment was achieved by cerclage combined with C_3F_8 infusion. After a follow-up of 5-49 months (mean 23.9 ± 1.3 months), all 50 eyes (100%) had retinal reattachment.

Recovery of Vision

The preoperative BCVA and postoperative BCVA (5-grade notation) were 2.82 ± 0.69 and 4.34 ± 0.49 , respectively, in 42 patients with macular retinal detachment, and the difference was statistically significant ($t = 13.72$, $p < 0.01$).

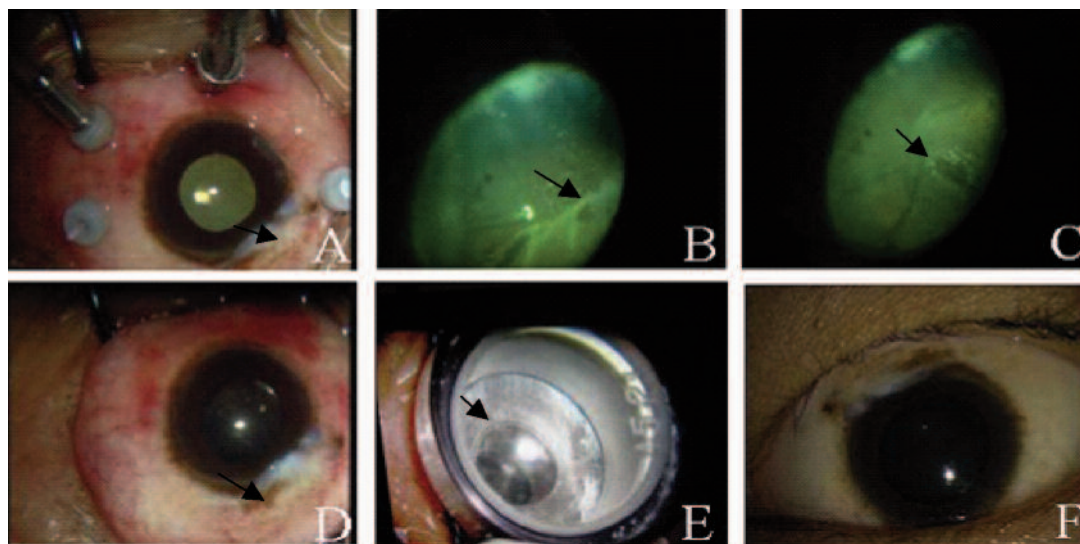


Figure 1. **A**, Micro-trocar was placed in infratemporal, supertemporal, and supernasal pars plana, the puncture sites of supernasal and supertemporal trocar was kept away from the follicle of previous glaucoma surgery (arrowhead), the chandelier was inserted in the 6 o' clock direction. **B**, Bimanualness performance under chandelier lighting, with one hand pressing peripheral retina by surgical device and the other hand holding vitreous cutter to perform high-speed vitrectomy to the retinal surface around the tear (arrowhead). **C**, Bimanualness was performed under chandelier lighting, with one hand pressing the retina and the other hand performing fundus laser around the tear (arrowhead). **D**, At the end of this surgery, the trocar was removed with a properly aligned un-sutured scleral incision, resulting in a smooth conjunctival surface and no suture irritation. The follicle of previous glaucoma surgery was intact without being dislocated (black arrowhead) and only slight hemorrhage could be seen in the inferior bulbar conjunctiva. **E**, At the end of this surgery, the IOP was measured with a simple applanation tonometer. As shown in the figure, the watermark on corneal surface overlapped with the outer ring and the IOP was 15 mmHg. **F**, Two weeks after the surgery, the conjunctival hyperemia subsided and no scar was formed.

The preoperative and postoperative BCVA were 4.61 ± 0.19 and 4.70 ± 0.19 , respectively, in 8 patients without macular retinal detachment, and the difference was not statistically significant ($t = 2.20$, $p = 0.064$). For 16 patients with good compliance, BCVA was recovered after 1-6 months (mean 3 months) postoperatively.

Discussion

Undoubtedly, vitrectomy was the preferred option for the patients with rhegmatogenous retinal detachment (RRD) grade C PVR. However, it was controversial whether scleral buckling and standard 3-channel vitrectomy was right for RRD grade C PVR¹.

The objective of rhegmatogenous retinal detachment surgery is to identify and close all retinal tear, promote adhesion between retinal neurosensory layer and purpurogenous membrane, and eliminate or relieve the tension of retina by vitreous body. Scleral buckling is a commonly used procedure for RRD as no intraocular operation is needed. Therefore, the postoperative infection is decreased and the lens is not injured due to this procedure. However, SBRRD is characterized by large amount of subretinal fluid and high retinal protrusion. Therefore, conventional scleral buckling can fail due to inaccurate tear location, difficult to control condensation amount and extremely softened eyeball after drainage. Generally, the fish-mouth phenomenon in the tear can only be eliminated by scleral buckling combined with infusion of air into vitreous cavity. However, as neither vitrectomy was performed nor the vitreous tension was relaxed, the pressure of air bubbles can usually result in new tear formation². As previously reported, the successful rate of one scleral buckling for the treatment of SBRRD was 90%². Although anatomical retinal reattachment could be achieved in some patients postoperatively, the recovery of visual function was not satisfactory. This could be attributed to the morphological and diopter changes in the eye caused by scleral buckling postoperatively. Meanwhile, the macular structural abnormality rate in the eye with retinal reattachment after scleral buckling as determined by Optical Coherence Tomography (OCT) was up to 71%, but the concealed macular structural abnormality rate was 37.5% after vitrectomy³. In comparison to vitrectomy, scleral buckling required extensive cut bulbar conjunctiva, separation and traction in rectus, and resultant

extensive conjunctival scar. The disruption of ocular surface structure could result in severe irritation and lead to or accelerate the xerophthalmia in patients.

Vitrectomy can eliminate the risk factors (freely dissociated retinal pigment epithelium, growth factors, cytokines and pro-inflammatory factors, etc.) causing postoperative PVR in vitreous cavity in comparison to scleral buckling. The intraocular laser-closed retinal tear is beneficial for not only precise location but also reduced dissociation and dissemination of retinal pigment epithelium, thus, decreasing the risk of postoperative PVR. The maintenance of stable IOP can avoid the subretinal hemorrhage and even suprachoroidal hemorrhage due to excessively low IOP after intraoperative drainage in scleral buckling. It can also avoid retinal degeneration around the leakage, small tear and suture needle perforation in the sclera, which could result in complications such as iatrogenic retinal tears. Since SBRRD is located above the tear, vitrectomy combined with filling of laser and air can reliably close the retinal tear and require no cerclage or external pressure with silica gel. Therefore, neither the shape of eyeball nor the diopter will be changed. However, since conventional 20-G vitrectomy requires a conjunctival incision larger than 20-G scleral puncture, a conjunctival scar can be seen postoperatively, and the frequent entry of surgical devices through the scleral puncture can result in the complications associated with the incisions, such as jagged-edge tear, vitreous body embedded in the scleral incision that can lead to relapse of retinal detachment.

Eckardt et al⁴ reported that 23-G minimally invasive vitrectomy had advantages in comparison with 25-G vitrectomy, such as small incision, fast healing; small sclera scar, no suture irritation, small postoperative astigmatism and patient's comfort. The trocar used in this procedure could reduce the complications associated with the surgical incision. Meanwhile, it could overcome the limitations of 25-G vitrectomy, including insufficient infusion affecting the surgical efficiency, soft microscopic-device and pool operability. With the advent of high-speed vitrectomy machine as well as modified microscopic surgical devices and lighting, 23-G vitrectomy has been gradually applied^{5,6}. But 23-G vitrectomy in the treatment of RRD has not been much reported. 23-G vitrectomy combined with chandelier in the treatment of SBRRD has not been reported previously.

The use of chandelier could not only compensate the limitations of 23-G optical fiber lighting such as insufficient brightness and range, but also allows the bimanualness under wide-angle lens. Non-contact wide-angle lens required no corneal suture to fix the scope ring, avoided the ocular surface hemorrhage due to suture. Thus, it allowed clear surgical field to achieve real minimal invasiveness. The non-contact lens hung below the surgical microscope required no fixation, consequently allowed independence of assistants. The 3-D model we used could control the cutting rate and negative pressure freely. High-rate of 2500 times/min in vitrectomy allowed safer operations near retina and could efficiently reduce the occurrence of iatrogenic retinal tear. This procedure used tunnel incision, which is well closed. The intraoperative IOP was stable, and could be adjusted to 15 mmHg by a simple applanation tonometer at the end of vitrectomy, preventing an excessive filling of air in the vitreous cavity, which may result in impaired visual function due to high IOP. In this study, no intraoperative iatrogenic retinal tear or the complications associated with surgical incision occurred. The successful rate of retinal reattachment by one surgery was 98%, which is higher than that of scleral buckling at 90% [2], and also that of 23-G vitrectomy at 91.7% for the treatment of RRD⁷.

Earlier low IOP after conjunctival suture-free minimally invasive vitrectomy increased the risk of choroidal detachment, suprachoroidal hemorrhage and intraocular infection. In case of 23-G minimally invasive vitrectomy with oblique self-closed scleral tunnel incision, the appearance of IOP was lower than that of 25-G vitrectomy with vertical incision⁴. The postoperative risk factors of earlier low IOP included high myopia, frequent entry of surgical devices in to eyes and decreased elasticity of the scleral incision due to the history of multiple surgeries. It was reported⁸ that the prevalence of late low IOP after conjunctival suture-free 23-G vitrectomy was 21.1% (IOP $\leq$ 9 mmHg) and 10.5% (IOP $\leq$ 5 mmHg). In this study, there were 25 eyes (50%) with medium-high myopia. In order to avoid severe complications, such as suprachoroidal hemorrhage due to low postoperative IOP, we closed the incision with incision massage, infusion of viscoelastics and suturing conjunctival incision. As a result, the prevalence of postoperative low IOP (IOP $\leq$ 5 mmHg) was only 2%. IOP recovered to normal level after pressure dressing on the next day, and no complications associated with low

IOP, such as choroidal detachment, hemorrhage, and endophthalmitis occurred. One single continuous conjunctival suture could not enlarge the conjunctival incision; thus, it avoided excessive conjunctival damage and maintained normal conjunctival tissues as far as possible. The postoperative conjunctival hyperemia and irritation signs were mild, and the conjunctival hyperemia essentially subsided 2 weeks postoperatively. Therefore, minimally invasive vitrectomy was particularly suitable in combination with glaucoma surgery and could maintain intact conjunctiva for other subsequent intraocular surgeries, such as glaucoma and cataract surgeries.

The excessive filling of air during vitrectomy may result in irreversible damage to visual function due to high IOP. Therefore, we used a simple applanation tonometer to set IOP at 15 mmHg and adjusted the filling volume of air into vitreous cavity, to prevent intraoperative high IOP. Transient high IOP was also an earlier complication after vitrectomy, and was associated with trabecular meshwork edema and inflammatory substance occlusion in trabecular meshwork postoperatively. In this study, 16 out of 50 eyes had transient high IOP postoperatively, which recovered to normal level 7.4 ± 4.5 days after intravenous, oral or topical administration of lowering-IOP medication. High IOP may cause irreversible damage to optic nerves; therefore, the postoperative changes in IOP should be closely monitored and appropriately treated to preserve visual function.

The occurrence of lens cataract and progressive aggravation is a common complication after vitrectomy^[9]. In comparison with senile cataract, it has the following characteristics: 1) the lens nucleus is apparently hardened, the suspensory ligament of lens is relatively fragile, the lens and lens nucleus tends to detach and enter into vitreous cavity; 2) the support of lens is lost after vitrectomy; thus, the intraoperative low IOP and the resultant contracted pupil makes surgery more difficult. In the current study vitrectomy combined with phacoemulsification was performed in patients (14 eyes) with complicated cataracts, and complicated cataract extractions were avoided afterwards.

Conclusions

We demonstrated that the minimally invasive 23-G vitrectomy combined with chandelier for

the treatment of SBRRD was safe and efficacious, with mild responses and fewer complications therefore, suitable for clinical applications.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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