Original Article

Surgical Management of Retinal Detachment Resulting from Macular Hole in a Setting of High Myopia

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Abstract

Purpose: To evaluate the anatomical and visual outcomes of pars plana vitrectomy (PPV) with internal limiting membrane (ILM) peeling and use of retinal tamponade for retinal detachments resulting from macular hole (MHRD) in highly myopic eyes.

Methods: Twenty-nine highly myopic patients (29 eyes) underwent PPV with ILM peeling and retinal tamponade for MHRD were enrolled. Demographics and best-corrected visual acuity (BCVA) were measured preoperatively and at final follow-up. Anatomical success and macular hole closure were analyzed.

Results: Patients' mean age of patients was 58.7±10.6 years, mean follow-up was 11.7±7.4 months. Twenty three eyes (23/26, 88.5%)undergoing primary PPV combined with ILM peeling had successful initial retinal reattachment, including 19 eyes (19/19, 100%) with silicone oil tamponade and in 4 eyes (4/7, 57.1%) with sulfur hexafluoride (C3F8) tamponade. Overall anatomical success was achieved in 27 eyes (27/29, 93.1%). The macular hole closure was observed in 17 eyes (17/26, 65.4%) with final anatomical success. Compared to preoperative BCVA, the mean postoperative BCVA in the eyes with anatomical success was significantly improved (P = 0.007, Wilcoxon signed rank test).

Conclusion: As a primary or secondary procedure, PPV combined with ILM peeling and usage of retinal tamponade serves as an effective method for MHRD in highly myopic eyes. (***Eye Science 2012; 27: 69-75***)

Keywords: retinal detachments; macular hole; high myopia; pars plana vitrectomy; internal limiting membrane

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Introduction

Retinal detachment resulting from macular hole (MHRD) in patients with high myopia is a common type of rhegmatogenous retinal detachment, which was usually found in female patients. Past three decades, various methods for eyes with MHRD have been reported[1-10], such as posterior episcleral buckling, pars plana vitrectomy (PPV) with or without internal limiting membrane (ILM) peeling or use of retinal tamponade. The anatomical success rate ranged from 41.7% to 100% by PPV with and without ILM peeling or use of retinal tamponade[6-10]. However, the best procedure of initial treatment for MHRD in highly myopic eyes has still been not determined. Furthermore, due to failure of the primary procedure, multiple intraocular operations not only increase patient's economic burden, but also have potentially harmful effects on the function of the retina. This study describes the anatomical and visual outcomes of PPV with ILM peeling and use of retinal tamponade in MHRD eyes.

Methods

We reviewed the medical records of patients who had MHRD between October 2008 and July 2011 at Sir Run Run Shaw Hospital, College of Medicine, Zhejiang University. Twenty-nine consecutive eyes of 29 patients underwent comprehensive ophthalmologic examinations, including best-corrected visual acuity (BCVA), measurement of axial length (AL), non-contact tonometry, and dilated indirect slit-lamp examination of the anterior and posterior segment. The inclusion criteria were clinical presentation of

RD caused by MH; an AL > 26.00 mm in an eye with RD; myopia of ≤ 6.0 diopters; and a follow-up period of > three months from the last intraocular surgery. Eyes with preexisting ocular diseases (except for cataract) were excluded. Other exclusion criteria included retinal vasculopathy, such as diabetic retinopathy, and retina vein occlusion. All PPV surgeries were performed by one surgeon. All axial lengths and staphyloma were measured by A-scan or B-scan ultrasonography. Posterior staphyloma was confirmed by B-scan ultrasonography. Due to the ALs of two eyes being missed, the ALs of 27 eyes were recorded.

Each patient was informed about the risks and benefits of the surgery, and written informed consent was obtained before the surgery in accordance with the Ethics Committee of the Affiliated Sir Run Run Shaw Hospital of Zhejiang University. In three eyes, failed initial procedures had been performed prior to referral to our hospital, including encircling buckle in one case, PPV with sulfur hexafluoride (C3F8) tamponade in one case, and intravitreal gas injection in one case. Simultaneous phacoemulsification with intraocular lens implantation was performed on 13 eyes. Phacoemulsification was performed on seven eyes at the follow-up, and six of the seven eyes underwent intraocular lens implantation.

All eyes included in this study were treated with conventional 20-gauge or 23-gauge three-port PPV. The ILM around the macular hole within the major temporal vascular arcades was peeled off carefully with intravitreal ILM forceps. ILM peeling without adjuvants procedure was performed in 25 eyes, and was performed with the indocyanine green (ICG) staining procedure in four eyes. The ICG solution was prepared by dissolving 25 mg/vial of dry ICG dye in 5 mL of 50% glucose solution, and was mixed with 5 mL distilled water to obtain a final ICG concentration of 2.5 mg/mL (0.25%).

The peripheral retina was carefully examined for retinal breaks with scleral depression. If retinal breaks in the peripheral retina were found, local photocoagulation was operated. Fluid-air exchange with drainage of subretinal fluid through the macular hole was then performed, and the air was replaced with silicone oil (SO) or C3F8. Silicone oil with a viscosity of 5000 centistokes was used. The concentration of C3F8 was 16%. The type of tamponade was surgeon-dependent. Patients were asked to maintain a prone position postoperatively for at least 2 weeks. Silicone oil removal (SOR) was performed at the patient's convenience at least 6 months after silicone oil tamponade, or if complicated cataract had developed, or earlier if intraocular pressure (IOP) was not controlled under 21 mm Hg, even with the use of antiglaucomatous drops.

Initial anatomical success, final anatomical success, macular hole closure, BCVA, and intraocular pressure were analyzed. Optical Coherence Tomography (SD-OCT, Carl Zeiss Meditee, Dublin, CA) was done at the end of one month document MH status. Anatomical success was defined as continuous reattachment of the retina at their final visits, which occurred at least three months after the surgery. Macular hole closure was defined as restoration of full- or partial-thickness retinal reflection over the retinal pigment epithelium[25]. Decimal visual acuity was converted to the logarithm of the minimal angle of resolution (logMAR) for statistical analysis. Visual acuity of light perception, hand motions, and counting fingers were arbitrarily assigned equivalents of 2.6, 2.4, and 2.1 logMAR units, respectively. Statistical analysis was performed using SPSS version 17.0. All continuous values were presented as mean±standard deviation (SD). A change no less than 0.3 logMAR units between preoperative and postoperative visual acuity was classified as improve ment or worsening of BCVA (as appropriate). A *P* value less than 0.05 was considered statistically significant.

Results

In this study, 29 eyes of 29 consecutive patients presenting with myopic MHRD were enrolled. There were 25 females and four males. The mean age of the patients was 58.7±10.6 years(range,36–76 years). The mean AL was 29.0±1.9 mm (range, 26.0-32.3 mm). Characteristics of the 29 eyes are shown in Table 1.

Of the 26 eyes that underwent primary PPV in our hospital, 23 (88.5%) had successful initial retinal reattachment (Figure 1), including 19 of 19 eyes with SO tamponade and four of seven eyes (57.1%) with C3F8 tamponade. In six eyes with initial anatomical

Table 1 Basic clinical characteristics of patients with MHRD

Characteristics	All patients(n=29)
Age (mean±SD, y)	58.7±10.6
Range	36 to 76
Sex	
Male	4(13.8%)
Female	25(86.2%)
Pre BCVA	
Light perception	1(3.4%)
Hand motion	3(10.3%)
Counting fingers	17(58.6%)
0.01–0.09	5(17.2%)
⩾ 0.1	3(10.3%)
Eye axial length (mean±SD, mm)	29.0±1.9
Range	26.0–32.3
Staphyloma	
Yes	12(44.4%)
No	15(55.6%)
Area of detachment of retina	
Located	11(37.9%)
Subtotal	16(55.2%)
Total	2(6.9%)
Status of lens	
Lens	24(82.8%)
Pseudophakic	4(13.8%)
Aphakic	1(3.4%)
Follow-up (mean±SD, mo)	11.7±7.4
Range	3 to 28

BCVA=best-corrected visual acuity; SD=standard deviation; MHRD = retinal detachments resulting from macular hole

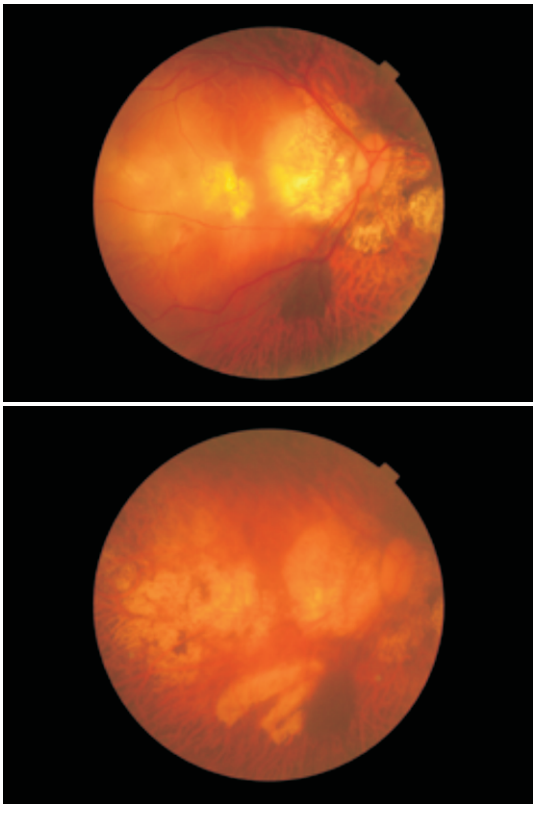

Figure 1 Preoperative and postoperative fundus photography of a 58-year-old female who underwent pars plana vitrectomy (PPV) with internal limiting membrane (ILM) peeling. (Top) fundus photography before surgery. The best corrected visual acuity (BCVA) was FC in the right eye. (Inferior) fundus photography at 12 months after surgery showed the retina was reattached. The final BCVA was FC in the right eye.

failure, the retina was reattached successfully in three eyes with secondary SO tamponade and one eye with additional C3F8 injection. However, the retinal reattachment of the eye with primary encircling buckle failure was still not successful after further PPV with SO tamponade, and the patient refused further intervention. One patient with primary PPV with C3F8 tamponade who had residual detachment that was localized on the superior temporal vessel arch also refused to undergo the secondary surgery (Table 2). The final anatomical success rate was 93.1% (27 of 29 eyes), including 22 eyes with SO tamponade and five eyes with C3F8 tamponade. Eight of 22 eyes (36.4%) underwent SOR. The mean time of SOR was 10.9 ± 4.0 months (7–17 months). However, the retina in one of eight eyes became detached again after SOR. After further silicone oil injection, the final reattachment was achieved successfully.

Examination with SD-OCT was routinely performed in 28 eyes after one month at the last surgery. Disregarding the two eyes with final anatomical failure, macular hole closure was obtained in 17 of 26 eyes(65.4%) (Figure 2), including 13 of 22 eyes (59.1%) with silicone oil tamponade, and four eyes with C3F8 tamponade. There were no significant differences found for the age, AL, staphyloma, preoperative BCVA, and tamponade type between the eyes with and without MH closure (Table 3).

In 27 of 29 eyes (with final anatomical success), the mean preoperative BCVA was 1.9±0.5 log MAR, and the final mean postoperative BCVA was 1.4 ± 0.7. Compared to preoperative BCVA, the final mean postoperative BCVA was significantly improved (P = 0.007, Wilcoxon signed rank test). Changes in preoperative and postoperative visual acuity are

Table 2 Primary and secondary surgical techniques for the repair of MHRD in 29 highly myopic eyes in our hospital

Primary surgical techniques	No.of eyes	Primary anatomical success	Primary anatomical failure	Additional surgery	Secondary anatomical success	Secondary anatomical failure
Vitrecctomy with C3F8 tamponade	7	4(57.1%)	3(42.9%)	2△	2(100%)	0
Vitrectomy with SO tamponade	19	19(100%)	0	0(0%)	0	0
Others*	3	–	–	3○	2(66.7%)	1(33.3%)

△Vitrectomy and silicone oil.

○One eye with secondary silicone oil tamponade and one eye with additional C3F8 injection.

* Three patients with failed initial procedure were referred to the authors.

SO = silicone oil; C3F8 = sulfur hexafluoride

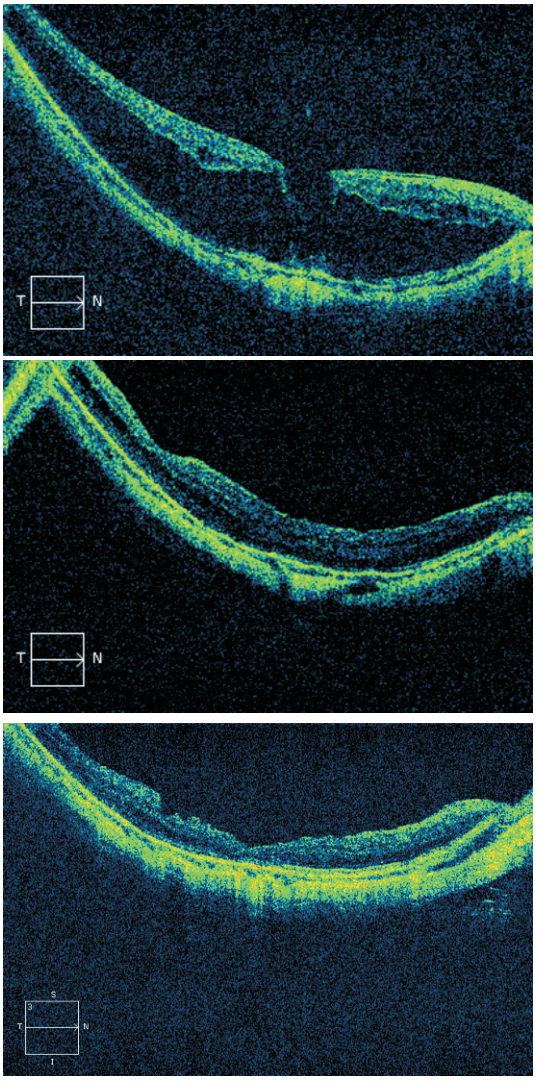

Figure 2 Preoperative and postoperative spectral-domain optical coherence tomographic (SD-OCT) images of a 57-year-old female who underwent pars plana vitrectomy (PPV) with internal limiting membrane (ILM) peeling. (Top) SD-OCT before surgery. The visual acuity (VA) was FC in the right eye. (Middle) SD-OCT of the closed macular hole 2 months after surgery, but the retinal was not reattachment completely. (Inferior) SD-OCT image obtained the closed macular hole 18 months after surgery and the retinal was reattachment completely.

Table 3 Univariate analysis between eyes with macular hole closure and eyes with macular hole that remained after pars planavitrectomy for retinal detachment attributable to macular hole in highly myopia

	MH closed *n*=17(65.4%)	MH persisted *n*=9(34.6%)	*P* value
Mean age ± SD, years	58.6±11.1	58.3 ± 10.5	
Range	36–76	46–75	.83a
Mean axial length*±SD,mm	29.2±1.9	29.2±2.1	
Range	26.0–32.0	26.5–32.3	.88a
Staphyloma*			
Yes	7(29.2%)	4(16.7%)	
No	9(37.5%)	4(16.7%)	.78b
Preoperative BCVA			
Range	HM to 20/125	HM to 20/200	.18a
Retinal tamponade			
SO	13(50%)	9(34.6%)	
C3F8	4(15.4%)	0(0%)	.12b

HM = hand motion.

BCVA = best-corrected visual acuity; SD = standard deviation; SO = silicone oil; C3F8 = sulfur hexafluoride.

a Mann–Whitney U test.

b Fisher exact probability test.

* The data of two eyes were missing.

shown in Figure 3. Comparing to the preoperative BCVA of the 27 eyes with final anatomical success, the postoperative BCVA had improved in 15 eyes (55.6%), maintained at the same level in 9 eyes (33.3%), and had decreased in 3 eyes (11.1%). There were no significant correlations between macular hole closure and improvement of BCVA (Pearson correlation coefficient, P=0.82), or between macular hole closure and postoperative logMAR visual acuity (Pearson correlation coefficient, P = 0.23).

Sixteen of 29 eyes which underwent PPV in our hospital had high IOP (>21 mmHg) from the first

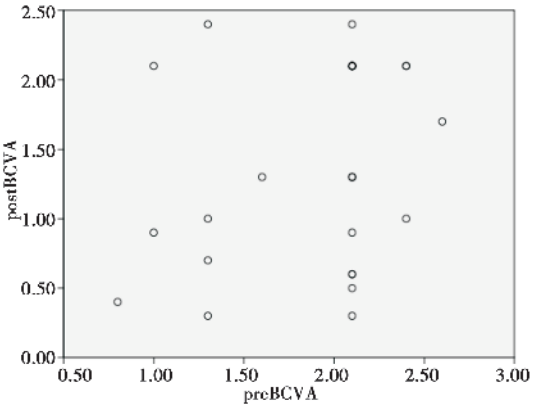

Figure 3 Changes in preoperative best-corrected visual acuity (preBCVA) and postoperative best-corrected visual acuity (postBCVA) in the 27 of 29 eyes with final anatomical success. BCVA was measured using the Decimal chart at baseline and at the final visit. BCVA was converted into logarithm of the minimal angle of resolution (logMAR) format. Counting fingers, hand motion and light perception was considered as logMAR 2.1, 2.4 and 2.6 units, respectively.

postoperative day, including 15 eyes with silicone oil tamponade and one eye with C3F8 tamponade. Thirteen silicone oil eyes fell to within normal IOP range after the use of antiglaucomatous drops. However, one eye in which the IOP was still high (>21 mmHg), even with the use of antiglaucomatous drops, underwent silicone oil removal at 9 months after the primary surgery, and the IOP finally fell to normal range. One eye required silicone oil removal combined with trabeculotomy to lower IOP at 7 months after the initial surgery, and eventually fell to within normal IOP range. One eye with C3F8 tamponade fell to normal IOP range with the use of antiglaucomatous drops.

Discussion

ILM peeling may decrease the tangential traction on the retina and increase the elasticity of the retina, as described by Ishida et al[11]. Therefore, in this study, all eyes experienced ILM peeling. The initial anatomic success rate of MHRD in high myopia treated by PPV with retinal tamponade was 88.5%, which was similar to those of previous reports[6–10]. However, the initial anatomic success rate of silicone oil tamponade was 100%, which was higher than that of C3F8 tamponade. It might be due to the duration of tamponade with silicone oil being enough to promote proliferation of glial tissue[12]. However, since the choice of tamponade agents was dependent on surgeon in this study, the efficacy of the different tamponade agents could not be estimated objectively.

Previous studies on RD caused by macular hole treated by PPV combined with ILM peeling have suggested a macular hole closure rate ranging from 44% to 100%[6, 9–10, 13, 24]. In this study, the total macular hole closure rate was 64.2% after PPV with retinal tamponade. The macular hole closure rate in the eyes with SO tamponade was 59.1%. It was suggested that the macular hole closure seems to be affected by SO. A previous study[14] has found that silicone oil may fill the underlying macular hole and directly contact the retinal pigment epithelium (RPE) when the patients assume the face-down positioning. The subfoveal RPE cells could be injured by the SO and interrupt macular holes closure. In vitro experiment, it was also confirmed that silicone oil may have a direct effect on cultured RPE cells[15]. In this study, macular hole closure in all eyes with C3F8 tamponade was achieved. This may be due to intraocular gases having the higher surface tension, which makes deformation of the bubble into the macular hole and this affecting the RPE less likely[14]. However, because of the small number of eyes with C3F8 tamponade, we could not compare macular hole closure rate between types of tamponade agents.

The present study showed significant improvement in BCVA after surgery, which is similar to findings of other reports[6,10,17]. However, it is still controversial whether the macular hole closure is related to improved visual prognosis. Hideo Nakanishi et al[17]. reported that there was no significant difference for final BCVA after surgery, and Ikuno et al[24]. argued that macular hole closure was significantly related to the improvement of postoperative BCVA. The present study found postoperative BCVA was not significantly different between eyes with and without macular hole closure, which may suggest that reconstruction and integrity of the foveal external limiting membrane (ELM) in the early postoperative period may have the potential for better visual outcomes[26–29]. Thus, we inferred that, even if the macular hole persisted, the visual acuity of the eyes which ELM had

been reconstructed after surgery may be improved.

One of the common complications is elevated intraocular pressure after PPV[16-20]. In this study, 16 of 29 eyes (55.2%) had elevation of IOP after PPV procedure. Thirteen of 16 eyes were well controlled after being treated with topical antiglaucomatous drugs, which was similar to findings in previous report[22]. It is suggested that the topical antiglaucomatous drugs were effective enough for elevated IOP after PPV. Nishimura[10] considered the silicone oil removal operation was not recommended if the patients' IOP was normal with or without tropical drops for glaucoma. Jonas et al[23]. reported the silicone oil emulsification-related increase in IOP was reversible, and the removal of silicone oil may lead to ocular hypotony. Thus, if the patients did not wish for silicone oil removal, SOR was not performed actively.

Howerer, this study has some limitations. Firstly, it was a retrospective study without a control group. Secondly, not all the patients underwent SOR at follow-up, and we could not observe the anatomical status after SOR in all eyes with SO tamponade. Thirdly, the retinal tamponade was surgeon-dependent, and we could not evaluate the efficacy of different tamponade agents objectively. Therefore, further studies with larger sample sizes are needed to confirm these results.

In conclusion, for retinal reattachment resulting from macular hole in highly myopic eyes, PPV with ILM peeling and use of the retinal tamponade is an effective management method. However, which is the better type of retinal tamponade needs to be further confirmed. Above all, considering economic cost and surgery risks, most patients are reluctant to undergo secondary surgery.

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References

1 Gonvers M, Machemer R.A new approach to treating retinal detachment with macular hole.Am J Ophthalmol, 1982;94:468-472.

2 Kadonosono K, Yazama F, Itoh N, et al.Treatment of retinal detachment resulting from myopic macular hole with internal limiting membrane removal.Am J Ophthalmol, 2001; 131(2):203-207.

3 Ichibe M, Yoshizawa T, Murakami K, et al.Surgical management of retinal detachment associated with myopic macular hole: anatomic and functional status of the macula.Am J Ophthalmol, 2003;136(2):277-284.

4 Ripandelli G, Coppé AM, Fedeli R, et al.Evaluation of primary surgical procedures for retinal detachment with macular hole in highly myopic eyes: a randomized comparison of vitrectomy versus posterior episcleral buckling surgery.Ophthalmology, 2001;108 (12):2258-2264;discussion 2265.

5 Uemoto R, Yamamoto S, Tsukahara I, et al.fficacy of internal limiting membrane removal for retinal detachments resulting from a myopic macular hole.Retina, 2004;24 (4):560-566.

6 Fang X, Zheng X, Weng Y, et al.Anatomical and visual outcome after vitrectomy with triamcinolone acedonide-assisted epiretinal membrane removal in highly myopic eyes with retinal detachment due to macular hole. Eye, 2009;23(2):248-254.

7 Soheilian M, Ghaseminejad AK, Yazdani S, et al.Surgical management of retinal detachment in highly myopic eyes with macular hole. Ophthalmic Surg Lasers Imaging, 2007;38:15-22.

8 Li X, Wang W, Tang S, et al.Vitrectomy with Gas for Treating retinal detachment owingto macular hole in high myopes.Ophthalmology, 2009;116(6):1182-1187.

9 Kumar A, Tinwala S, Gogia V, et al.Clinical presentation and surgical outcomes in primary myopic macular hole retinal detachment.Eur J Ophthalmol, 2011;doi: 10.5301/ejo.5000012.

10 Nishimura A, Kimura M, Saito Y, et al.Efficacy of primary silicone oil tamponade for the treatment of retinal detachment caused by macular hole in high myopia.Am J Ophthalmol, 2011;151(1):148-155.

11 Ishida S, Yamazaki K, Shinoda K, et al. Macular hole retinal detachment in highly myopic eyes: ultrastructure of surgically removed epiretinal membrane and clinicopathologic correlation.Retina, 2000;20(2):176-183.

12 Rosa RH, Glaser BM, de la Cruz Z, et al.Clinicopathologic correlation of an untreated macular hole and a macular hole treated by vitrectomy, transforming growth

factor be-ta-2, and gas tamponade.Am J Ophthalmol, 1996;122(6):853-863.

13 Patel SC,Loo RH,Thompson JT,et al.Macular hole surgery in high myopia.Ophthalmology, 2001;108:377-380.

14 Oster SF,Mojana F,Bartsch DU,et al.Dynamics of the Macular hole-silicone oil tamponade interface with patient positioning as imaged by spectral domain optical coherence tomography.Retina,2010;30(6):924-929.

15 Friberg TR,Verstraeten TC,Wilcox DK.Effects of emulsification, purity, and fluorination of silicone oil on human retinal pigment epithelial cells.Invest Ophthalmol Vis Sci,1991;32: 2030-2034.

16 Henderer JD, Budenz DL, Flynn HW Jr, et al. Elevated intraocular pressure and hypotony following silicone oil retinal tamponade for complex retinal detachment: incidence and risk factors. Arch Ophthalmol,1999;117(2): 189-195.

17 Nakanishi H,Kuriyama S,Saito I,et al.Prognostic factor analysis in pars plana vitrectomy for retinal detachment attributable to macular hole in high myopia: a multicenter study. Am J Ophthalmol,2008;146(2):198-204.

18 Cheung BT,Lai TY,Yuen CY,et al.Results of high-density silicone oil as a tamponade agent in macular hole retinal detachment in patients with high myopia.Br J Ophthalmol, 2007;91(6):719-721.

19 The Silicone Study Group. Vitrectomy with silicone oil or sulfur hexafluoride gas in eyes with severe proliferative vitreoretinopathy:results of a randomized clinical trial.Silicone Study Report 1. Arch Ophthalmol,1992; 110(6):770-779.

20 Budenz DL,Taba KE,Feuer WJ,et al.Surgical management of secondary glaucoma after pars plana vitrectomy and silicone oil injection for complexretinal detachment. Ophthalmology,2001;108(9):1628-1632.

21 Wolfensberger TJ,Gonvers M.Long-term follow-up of retinal detachment due to macular hole in myopic eyes treated by temporary silicone oil tamponade and laser photocoagulation.Ophthalmology,1999;106 (9):1786-1791.

22 Romano MR, Angi M, Romano V, et al. Intraocular pressure changes following the use of silicone oil or Densiron 68 as endotamponade in pars planavitrectomy.

23 Clinical Ophthalmology,2010;4:1391-1396.
Jonas JB,Knorr HL,Rank RM,et al.Intraocular pressure and silicone oil endotamponade. Journal of Glaucoma, 2001;10:102-108.

24 Ikuno Y,Sayanagi K,Oshima T,et al.Optical coherence tomographic findings of macular holes and retinal detachment after vitrectomy in highly myopic eyes.Am J Ophthalmol,2003;136(3):477-481.

25 Ip MS, Baker BJ, Duker JS, et al. Anatomical outcomes of surgery for idiopathic macular hole as determined by optical coherence tomography.Arch Ophthalmol, 2002; 120(1):29-35.

26 Wakabayashi T,Fujiwara M,Sakaguchi H,et al.Foveal microstructure and visual acuity in surgically closed macular holes: spectral-domain optical coherence tomographic analysis. Ophthalmology,2010;117 (9):1815-1824.

27 Itoh Y,Inoue M,Rii T,et al.Significant Correlation Between Visual Acuity and Recovery of Foveal Cone Microstructures After Macular Hole Surgery. Am J Ophthalmol, 2012; 153: 111-119.

28 Wakabayashi T,Oshima Y,Fujimoto H,et al.Foveal microstructure and visual acuity after retinal detachment repair.Ophthalmology, 2009; 116(3):519-528.

29 Haritoglou C,Gass CA,Schaumberger M,et al. Macular changes after peeling of theinternal limiting membrane in macular hole surgery.Am J Ophthalmol,2001; 132(3): 363-369.