A METHOD TO DECREASE THE FREQUENCY OF UNINTENTIONAL SLIPPAGE AFTER VITRECTOMY FOR RHEGMATOGENOUS RETINAL DETACHMENT

CHIEKO SHIRAGAMI, MD,* KOUKI FUKUDA, MD,* HIDETAKA YAMAJI, MD,* MISAKO MORITA, Co,* FUMIO SHIRAGA, MD†

Purpose: To investigate a method for preventing retinal slippage after standard vitrectomy for rhegmatogenous retinal detachment.

Methods: Eighty six eyes with bullous rhegmatogenous retinal detachment underwent successful standard vitrectomy. Patients were divided into 2 groups. In Group 1, 44 patients started face-down positioning at approximately 10 minutes after the end of the surgery. In Group 2, 42 patients started face-down positioning immediately at the end of the surgery. Postoperative retinal slippage was determined by fundus autofluorescence at 1 month postoperatively. Statistical analysis examined several factors to determine the association between the start time of the face-down positioning and retinal slippage.

Results: Retinal slippage occurred in 63.6% of Group 1 and in 24.0% of Group 2 patients. This difference was statistically significant ($P = 0.004$, Fisher's exact probability test). Both the extent of retinal slippage ($P = 0.029$) and the face-down position ($P < 0.001$) were significantly associated with the retinal slippage.

Conclusion: Earlier implementation of face-down positioning may prevent retinal slippage after surgery in eyes with rhegmatogenous retinal detachment treated by standard vitrectomy.

RETINA 0:1–6, 2014

Pars plana vitrectomy (PPV) is a common procedure used to repair rhegmatogenous retinal detachment (RRD).[1,2] For giant tears, bullous RRD, and retinal breaks with marked vitreous traction, primary PPV is the most commonly used treatment. The use of perfluorocarbon liquids (PFCL) has improved both safety and effectiveness of PPV surgery for retinal detachments.[3]

In our previous fundus autofluorescence (FAF) study that examined eyes treated with standard vitrectomy and gas injection for bullous RRD, in some cases, we found that the retina moved downward postoperatively.[4] The hyperautofluorescent lines shown by the FAF were located superior and parallel to the retinal vessels. These findings suggest that unintentional postoperative retinal translocation may easily occur in patients with large retinal detachments or macular detachments. Our previous study also found that although approximately half of our patients demonstrated excyclotorsion and/or vertical deviation on orthoptic examination, none of these patients complained of binocular diplopia.

Immediately after our previous study, we encountered one patient who complained of severe binocular diplopia after vitrectomy for RRD. Pandya et al[5] have reported that retinal slippage may develop after performing PPV with gas injection for intraocular tamponade. Furthermore, they suggested that this slippage could also be responsible for several disturbing symptoms, such as vertical diplopia and distorted vision. Even if the retina is totally reattached during PPV, at the end of the surgery, subtle subretinal fluid remains

From the *Department of Ophthalmology, Kagawa University Faculty of Medicine, Kagawa, Japan; and †Department of Ophthalmology, Okayama University Medical School, Okayama, Japan.

None of the authors have any financial/conflicting interests to disclose.

Reprint requests: Chieko Shiragami, MD, Department of Ophthalmology, Kagawa University School of Medicine, 1750-1 Ikenobe Miki-cho, Kagawa 761-0793, Japan; e-mail: chappi@kms.ac.jp

in these patients with RRD. After these surgeries, patients routinely are placed in a sitting position for a short time before they assume a face-down position. During this period, the force of gravity may cause the retina to move slightly downward. Therefore, we decided to investigate whether the retinal displacement that occurs after surgery in eyes with RRD treated with standard vitrectomy and gas injection could be prevented by simply placing patients in a face-down position at an earlier time point during the procedure.

Patients and Methods

Between December 2006, and November 2010, 86 eyes of 86 patients with RRD involving 1 or more quadrants underwent successful standard PPV with 20% sulfur hexafluoride gas injection at Kagawa University Hospital. None of the patients had any history of preoperative binocular diplopia. This study excluded any eyes that had undergone previous reoperations, silicone oil tamponade, or proliferative vitreoretinopathy.

The patients were classified into two groups. In Group 1, 44 patients underwent surgery from December 2006, to July 2008, and were placed in a face-down position in their rooms at approximately 10 minutes after completion of the procedure. In Group 2, 42 patients underwent surgery from August 2008, to November 2010, and were placed in a face-down position in the operating room immediately after completion of the procedure. Of the 44 cases in the Group 1, information on 43 of these patients was previously reported in a study that we published in 2010.[4]

Surgical Technique

Local anesthesia was induced by retrobulbar nerve block. A three-port PPV was performed in all cases using the Accurus vitrectomy system (Alcon Labs, Fort Worth, TX). Patients older than 50 years underwent combined cataract surgery. After separation and removal of the posterior hyaloid using a vitreous cutter, all of the vitreous traction on the retinal tears was removed, with the peripheral vitreous then subtotally shaved. In 63 eyes, PFCL (Perfluoron; Alcon Labs, Fort Worth, TX) was injected over the posterior pole and reached the posterior border of the retinal breaks through a 20-, 23-, or 25-gauge blunt cannula. Subretinal fluid was drained through the original retinal breaks in all 86 eyes using fluid–air exchange. After performing endolaser photocoagulation around the retinal breaks and completely removing the PFCL, 20% sulfur hexafluoride gas was used for internal tamponade in all cases. Neither scleral buckling nor retinotomy was performed. After the surgery, Group 1 patients were moved to the recovery room, with the face-down positioning started at 10 minutes to 20 minutes after the end of the procedure. In the Group 2 patients, the face-down positioning was started in the operating room immediately after completion of the surgery. Both patient groups maintained a face-down or other appropriate position over the next 7 days to 10 days after the surgery.

Ophthalmic Examinations and Fundus Photography

All patients underwent a regular ophthalmic examination, including measurement of the best-corrected visual acuity and fundus examination. Color fundus photography was performed using 50° fields of the panoramic image preoperatively and at 1 month postoperatively. Fundus autofluorescence imaging was recorded by a Topcon TRC-50DX fundus camera with 2 bandpass filters (based on the modification by Spaide,[6] with an excitation bandwidth of 500–610 nm and an emission bandwidth of 675–715 nm) and used to detect displacement of the retina at 1 month after the surgery.

Orthoptic Examination

All patients underwent an orthoptic examination at 3 months after surgery, with a synoptophore (Clement and Clark, Edinburgh, United Kingdom) used to measure the objective and subjective angles of deviation and fusion ability, as per a previously described method.[7] The elevation-dependent torsional disparity during various degrees of convergence was measured. With a synoptophore, subjects view two images at optical infinity through two eyepieces. These images fill the visual field so that nothing in the surrounding laboratory can be seen. The images can be independently rotated vertically and torsionally about a Fick system of gimbals for each eye.

Statistical Methods

Multiple logistic regression analysis was performed to determine whether a significant association exists between several factors including age, gender, PFCL use, macular status (on or off), the extent of retinal detachment, the timing of the start of the face-down position (independent variables), and the unintentional slippage of the retina (dependent variable). A P value of <0.05 was considered significant. All statistical analyses were performed using SPSS 17.0 statistical software.

The study was conducted in accordance with the recommendations of the Declaration of Helsinki and

was approved by the Institutional Review Board/ Ethics Committee of Kagawa University Hospital. After an explanation of the purpose of the study and the procedures to be used, a signed informed consent form was obtained from all patients before the surgery and examinations.

Results

Table 1 shows the summary of the clinical characteristics of the 86 Group 1 and 2 patients. Preoperative fundus examinations showed that 86 eyes had bullous RRD involving 1 or more quadrants. The mean age of all patients (55 men and 31 women) was 61.0 years (range, 39–86 years). Fundus examinations of the 44 Group 1 eyes demonstrated that RRD involved 1 quadrant in 2 eyes, 2 quadrants in 30 eyes, 3 quadrants in 10 eyes, and 4 quadrants in 2 eyes. Fundus examinations of the 42 Group 2 eyes showed that RRD involved 1 quadrant in 5 eyes, 2 quadrants in 19 eyes, 3 quadrants in 16 eyes, and 4 quadrants in 2 eyes. There was no statistically significant difference in the extent of RRD between the two groups.

After complete reattachment of the retina, FAF indicated that there were hyperautofluorescent lines located superior and parallel to the retinal vessels (Figure 1, A and B) in 38 of the 86 eyes (44.2%). These lines were within the vascular arcade in 28 of the 44 eyes (63.6%) in Group 1 and in 10 of the 42 eyes (24.0%) in Group 2. The difference between the groups was statistically significant ($P = 0.004$, Fisher's exact probability test). The frequency of retinal slippage determined by FAF was much less in the Group 2 versus the Group 1 eyes (Figure 2, A and B).

Multiple logistic regression analysis revealed that both the extent of RRD ($P = 0.029$) and the time the face-down position was started ($P < 0.001$) were significantly associated with the postoperative retinal slippage.

Of the 28 eyes in Group 1 with retinal slippage, 1° to 7° of extorsion were seen in 16 eyes, whereas 1° to 9° of vertical deviation were seen in 13 eyes. Of the single patient in Group 1 who complained of binocular diplopia (Figure 3), a synoptophore detected 7° extorsion and 9° of vertical deviation in the patient's eyes. As this patient continued to complain about his vision during the 4 months after the surgery, he was fitted for prism-adapted glasses. Although 1° to 4° of extorsion in 6 eyes and 1° to 4° of vertical deviation in 8 eyes were observed for the 10 eyes of Group 2 that had retinal slippage, none of these patients complained of any binocular diplopia or slant. Synoptophore examination of the remaining 48 patients without retinal slippage showed that there was no obvious strabismic deviation.

Table 1. Clinical Characteristics of Group 1 and Group 2 Patients Who Underwent Standard Vitrectomy for RRD

Group Number	Number of Patient Eyes	Age, Mean ± SD, Years	Gender		Quadrants of RRD				Presence of Superior RD, Eyes (%)	Macula Status		PFCL Use		Retinal Slippage After Surgery		Cyclodeviation		Vertical Deviation	
			Men	Women	1	2	3	4		On	Off	+	–	Present	Absent	Mean Degree (Mean ± SD)	Eyes	Mean Degree (Mean ± SD)	Eyes
1	44	60.0 ± 8.5	27	17	2	30	10	2	37 (84.1)	16	28	31	13	28	16	3.7 ± 1.4	16	2.9 ± 2.0	13
2	42	61.7 ± 9.5	26	16	5	19	16	2	36 (85.7)	20	22	32	10	10	32	1.5 ± 1.0	6	1.7 ± 1.2	8

COLOR

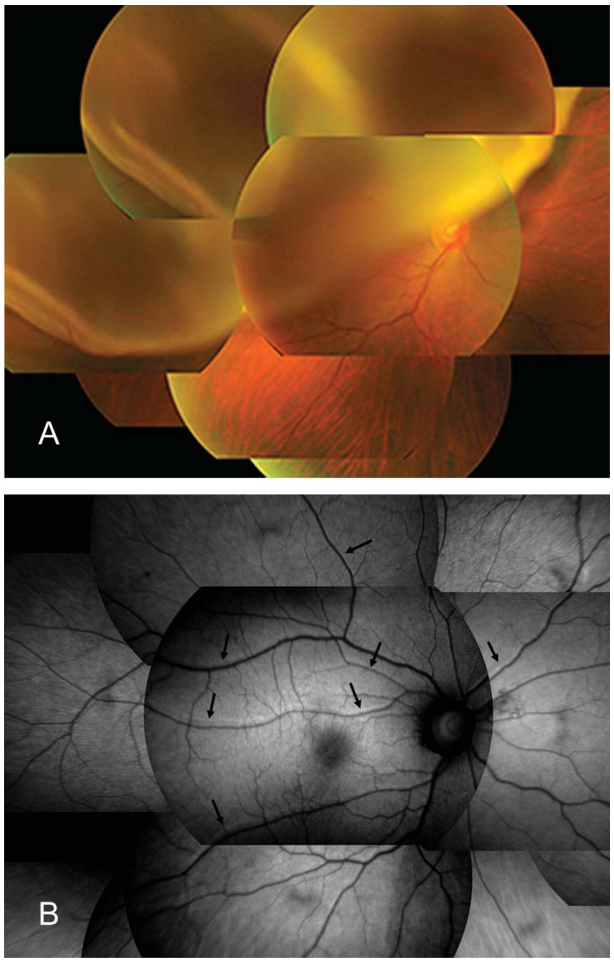

Fig. 1. A. Preoperative color photograph of an eye with bullous RRD from the Group 1 eyes. The RRD extended for 3 quadrants. **B.** An FAF image taken 1 month postoperatively shows hyperfluorescent lines (arrows) that are parallel and above the retinal vessels.

Discussion

Fundus autofluorescence is a noninvasive test that provides discrete funduscopic images based on stimulated emission of light from lipofuscin. Increased phagocytosis of the photoreceptor outer segments gives rise to the hyperautofluorescence.[6,8] Based on these findings, we suggested in a previous report that FAF imaging may be a valuable technique for assessing the retinal displacement (slippage) after standard vitrectomy for patients with RRD.[4]

Even when using PFCL along with intraocular gas tamponade to ensure drainage of the subretinal fluid, a small amount of the subretinal fluid usually remains immediately after the end of the PPV surgery. The observation that retinas also move downward after these surgeries suggests that the intraocular gas may be responsible for positional change. The reason for this change may be related to the downward shift of the

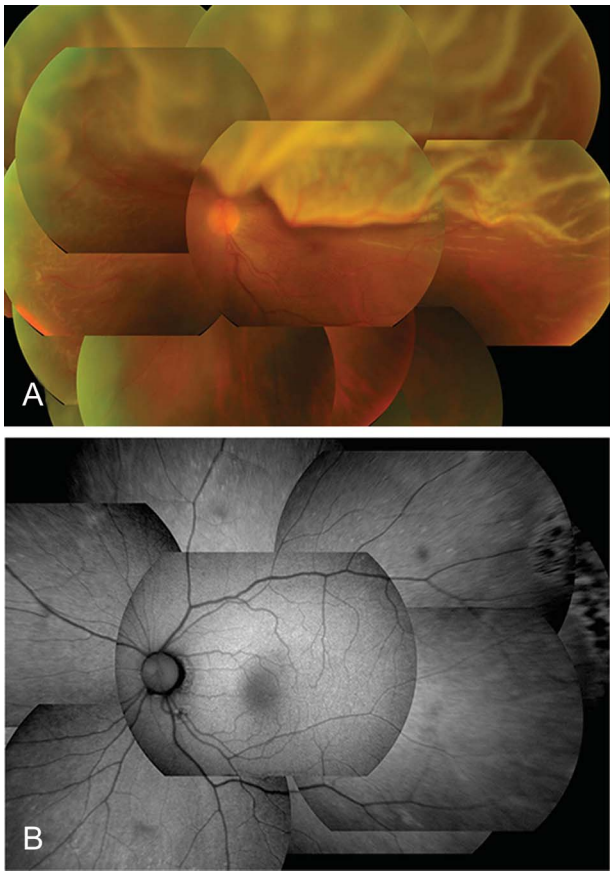

Fig. 2. A. Preoperative color photograph of an eye with bullous RRD from the Group 2 eyes. The RRD extended for 4 quadrants. **B.** An FAF image taken 1 month postoperatively demonstrates that there were no hyperfluorescent lines parallel to the retinal vessels.

residual subretinal fluid that occurs when patients are in a sitting position immediately after the PPV surgery. Moreover, as large retinal detachments, which include macular detachments, were found to be independently

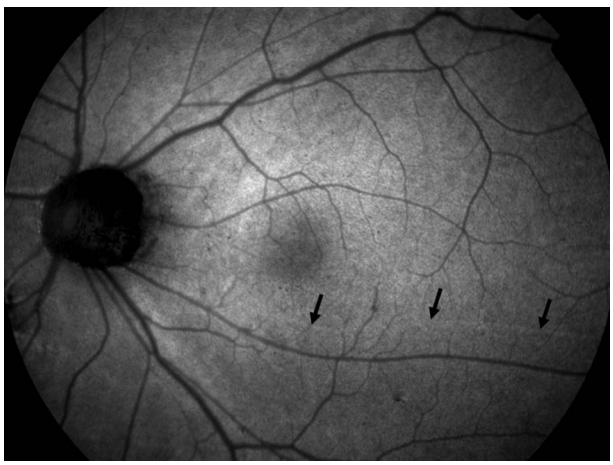

Fig. 3. The FAF image of a Group 1 eye taken 1 month postoperatively demonstrates hyperfluorescent lines (arrows). This patient complained about binocular diplopia due to the wide-angle foveal displacement within the vascular arcade after the surgery.

associated with the postoperative slippage of the retina, this may indicate that residual subretinal fluid can easily shift downward. In our previous study, all of the patients remained in a sitting position for approximately 10 minutes, with the face-down positioning only started once they were taken to the recovery room after the operation. Therefore, our findings suggest that the several minutes it took to get the patients into a face-down position may be an important period for preventing intraocular gas-caused retinal slippage. Ensuring that a strict face-down position is started and maintained as soon as the operation is completed may very well help to prevent retinal slippage.

Codenotti et al[9] reported that retinal slippage occurred in 52.2% of the RRD eyes treated by vitrectomy with gas or silicone oil tamponade. In addition, they also reported that occurrence of retinal slippage was significantly higher in eyes with gas tamponade (71.4%) as compared with eyes with silicone oil (22.2%). In both this study and the study by Codenotti et al, all patients treated with gas tamponade tried immediate face-down positioning, the rate of slippage in our Group 2 was 24.0%, and the rate of slippage in the study by Codenotti was 71.4%. The reason for the differences of the rate of slippage may be according to more severe and earlier starting the face-down positioning after completion of the surgery in this study. Furthermore, the retina shifted downward in all eyes with C_3F_8, although it shifted upward in all eyes with polydimethylsiloxane. However, RRD treatments that use silicone oil unfortunately require that patients undergo two operations, one for the injection and a second for removal of the silicone oil. Thus, to prevent retinal displacement without silicone oil use, a strict face-down position immediately after gas tamponade seems to be very important. After the patients remain in this face-down position for the first 24 hours, they can change their position to a more comfortable and appropriate one, as the subretinal fluid is most likely absorbed within the first 24 hours.

Postoperative retinal slippage was strongly correlated with the timing of the face-down positioning ($P < 0.001$). An early start time for the strict face-down positioning after vitrectomy with gas injection was also found to be the most important point for preventing retinal displacement. Furthermore, this method also proved to be both effective and safe for use in preventing binocular diplopia after vitrectomy for RRD.

Rotation of the retina leads to torsional and vertical strabismus.[10,11] However, cyclodeviation can easily be compensated for by the sensory fusion ability. This compensation is driven by the central nervous system and occurs without any clinically visible motor adaptation.[12] This torsion also greatly exceeds the maximum total amplitude of the cyclofusion, which can be as large as 15°.[13,14] In our previous study,[4] 59.3% of the patients with retinal slippage after PPV for RRD had 1° to 5° of extorsion, whereas 48.1% had 1° to 4° of vertical deviation.

In this study, however, there was only 1 patient in Group 1 who exhibited larger-angle extorsion and vertical deviation after PPV. As this patient complained of binocular diplopia, we performed synoptophore examination, which demonstrated that his eyes had a 7° of extorsion and 9° of vertical deviation. Both the cyclotorsion and the vertical deviation exceeded the sensory and motor fusion ability. Therefore, these results show that patients with RRD need to be carefully followed after PPV, especially about their binocular vision.

In conclusion, the results of this study suggest that the use of early face-down positioning in eyes with bullous RRD treated with standard vitrectomy and gas injection may prevent retinal slippage and the binocular diplopia caused by foveal translocation. Although the reviewer of FAF images was not masked as to the patient's study group, an additional long-term FAF prospective masked study after PPV for RRD may help to further clarify the importance of using early face-down positioning.

Key words: retinal slippage, rhegmatogenous retinal detachment, vitrectomy, fundus autofluorescence, face-down position, binocular diplopia, vertical deviation, extorsion, hyperautofluorescent line, lipofuscin.

References

1. Heimann H, Bartz-Shmidt KU, Bornfeld N, et al. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment: a prospective randomized multicenter clinical study. Ophthalmology 2007;114:2142–2154.
2. Stangos AN, Petropoulos IK, Brozou CG, et al. Pars-plana vitrectomy alone vs. vitrectomy with scleral buckling for primary rhegmatogenous pseudophakic retinal detachment. Am J Ophthalmol 2004;138:952–958.
3. Comaratta MR, Chang S. Perfluorocarbon liquids in the management of complicated retinal detachments. Curr Opin Ophthalmol 1991;2:291–298.
4. Shiragami C, Shiraga F, Yamaji H, et al. Unintentional displacement of the retina after standard vitrectomy for rhegmatogenous retinal detachment. Ophthalmology 2010;117:86–92.
5. Pandya VB, Hophd IV, Hunyor AP. Does unintentional macular translocation after retinal detachment repair influence visual outcome? Clin Exp Ophthalmol 2012;40:88–92.
6. Spaide RF. Autofluorescence from the outer retina and subretinal space: hypothesis and review. Retina 2008;28:5–35.
7. Sen DK, Singh B, Mathur GP. Torsional fusional vergences and assessment of cyclodeviation by synoptophore method. Br J Ophthalmol 1980;64:354–357.

8. Schmitz-Valckenberg S, Holz FG, Bird AC, Spaide RF. Fundus autofluorescence imaging: review and perspectives. Retina 2008;28:385–409.
9. Codenotti M, Fogliato G, Iuliano L, et al. Influence of intraocular tamponade on unintentional retinal displacement after vitrectomy for rhegmatogenous retinal detachment. Retina 2013;33:349–355.
10. Holgado S, Enyedi LB, Toth CA, Freedman SF. Extraocular muscle surgery for extorsion after macular translocation surgery: new surgical technique and clinical management. Ophthalmology 2006;113:63–69.
11. Ohtsuki H, Shiraga F, Morizane Y, et al. Transposition of the anterior superior oblique insertion as a treatment for excyclotorsion induced from limited macular translocation. Am J Ophthalmol 2004;137:125–134.
12. Guyton DL. Ocular torsion: sensorimotor principles. Grafes Arch Clin Exp Ophthalmol 1988;226:241–245.
13. Guyton DL. Clinical assessment of ocular torsion. Am Orthopt J 1983;33:7–15.
14. von Noorden GK. Clinical and theoretical aspects of cyclotropia. J Pediatr Ophthalmol Strabismus 1984;21:126–132.