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CLINICAL TRIAL REPORT

A Comparison of Adjustable Positioning and Free Positioning After Pars Plana Vitrectomy for Rhegmatogenous Retinal Detachment: A Prospective Randomized Controlled Study

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Purpose: To compare the effectiveness and safety of adjustable and free postoperative positioning after pars plana vitrectomy (PPV) for rhegmatogenous retinal detachment (RRD).

Design: Prospective, randomized controlled study.

Methods: A total of 94 eyes with RRD were enrolled from April 2020 to April 2023 and monitored postoperatively for at least 3 months. All patients underwent PPV combined with silicone oil injection or gas tamponade and were randomly divided postoperatively into two groups: an adjustable positioning group and a free positioning group. The success of the outcome was based on the retinal reattachment rate, best corrected visual acuity (BCVA), postoperative complications, and ocular biometric parameters such as anterior chamber depth (ACD) and lens thickness (LT).

Results: The initial retinal reattachment rate was 97.9% in the adjustable positioning group and 95.7% in the free positioning group, manifesting no statistical difference between the two groups. Similarly, no statistical difference was observed between the two groups in the final BCVA, which was significantly improved compared to the preoperative BCVA. The comparison of the 1-month postoperative ACD and LT with the preoperative values showed no statistically significant differences in the two groups. The rates of complications were not statistically different in the two groups.

Conclusion: After treating RRD using PPV, neither the adjustable nor the free postoperative positioning affected the retinal reattachment rate or the incidence of complications. Therefore, our study showed that it is safe and effective to adopt free positioning postoperatively, which may provide more options for patients with RRD undergoing PPV.

Keywords: rhegmatogenous retinal detachment, pars plana vitrectomy, adjustable positioning, free positioning

Introduction

Rhegmatogenous retinal detachment (RRD) is a serious acute ophthalmic disease that can lead to blindness without timely treatment. In recent years, with the application of transconjunctival sutureless vitrectomy (TSV) and wide-angle viewing system, pars plana vitrectomy (PPV), especially TSV, has been gaining popularity in the treatment of RRD with its advantages of a small incision, self-sealing, decreased surgical trauma, less postoperative inflammation, better postoperative comfort for patients, less postoperative astigmatism and an earlier visual recovery.[1–4] Prone positioning has traditionally been a routine requirement for patients after TSV and gas or silicone oil (SO) tamponade,[5,6] but this positioning requirement is a major source of postoperative discomfort, mental burden, and can cause physical complications, such as thrombophlebitis, ulnar nerve palsies and pulmonary embolism.[7–9] To this end, some studies have reported

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the efficacy of postoperative positioning concerning prone, adjustable and supine positioning after PPV for RRD.[1–4,10,11] However, there have not been thorough investigations on whether the postoperative free positioning is inferior to the success of TSV for RRD as compared to the adjustable positioning.

Our team has also achieved high success rates in treatment for RRD[12] and macular hole retinal detachment through patients' postoperative adjustable positioning.[13] In this study, we compared the safety and efficiency between adjustable and free postoperative positioning after PPV for RRD.

Methods

This prospective, randomized controlled study was approved by Ethics Committee of the Eye Institute of Shandong First Medical University and was conducted in accordance with the Declaration of Helsinki. The current study has been registered in the Chinese Clinical Trial Registry with the registration number: ChiCTR2000031323. As regards power calculation, with the value for power to be 90% and that for alpha 0.05, a sample size of 36 patients in each group was necessary (72 patients in total). The study included a total of 94 patients with RRD who underwent PPV combined with gas or SO tamponade at Qingdao Eye Hospital of Shandong First Medical University from April 2020 to April 2023 and were monitored for at least 3 months after surgery. All enrolled patients signed informed consent stating that they understand their condition and the relevant treatment plan.

Patients with RRD who underwent PPV were included in the study. The following exclusion criteria were imposed: 1) Unwillingness to participate in the study; 2) age under 18 and over 80 years; 3) macular hole retinal detachment or RRD combined with macular hole (MH); 4) proliferative vitreoretinopathy (PVR) C level or above; 5) intraocular surgical history (other than refractive surgery); 6) follow-up time less than 3 months.

Patients accepted to undergo all preoperative and postoperative ocular examinations, including best corrected visual acuity (BCVA), intraocular pressure (IOP), slit-lamp examination, axial length (AL), anterior chamber depth (ACD), lens thickness (LT), B-ultrasound, fundus photography, and OCT. Biometric parameters (including AL, ACD and LT) of the RRD eyes were measured using the Tomey OA-2000 Biometer (Tomey, Japan). The number, type, location and size of the retinal breaks, as well as the grading of the PVR were imaged by a panoramic scanning laser ophthalmoscope (SLO) (Optos, Scotland). Macular status was evaluated by OCT (Optovue, USA) and included examination for macular detachment and macular hole.

All patients underwent nearly identical procedures performed by the same surgeon (L. J.). PPV procedures were performed using a standard 25-gauge 3-port system (Constellation, Alcon, USA) and a non-contact wide-angle Viewing System (Resight, Carl Zeiss, Germany). Core vitrectomy was performed by intravitreal injection of triamcinolone acetonide to visualize the vitreous gel and the posterior hyaloid. Peripheral vitrectomy was performed under scleral pressure after core vitrectomy. Retinal breaks were closed with laser photocoagulation or cryopexy after fluid-gas exchange and retinal reattachment without perfluorocarbon liquid. The subretinal fluid was removed from the break as completely as possible using negative pressure suction to ensure retinal reattachment. Sometimes there was a little residual subretinal fluid after complete fluid-gas exchange, it could be absorbed by retinal pigment epithelium soon after surgery. In our trail, there was no case with giant retinal tears, and no case with great amount of residual subretinal fluid after surgery. If a lot of subretinal fluid was remained after complete fluid-gas exchange, it was recommended that patients adopted prone position for 24 hours after surgery to promote the absorption of subretinal fluid and avoid posterior retinal folds or retinal displacement and can adopt an adjustable position after 24 hours. The surgeon determined whether the vitreous cavity was filled with SO (Oxane 5700, Bausch & Lomb, Ireland) or perfluoropropane (C3F8, Alcon, USA) and whether the procedure must be combined with cataract extraction surgery. In our trail, no drainage retinotomy was performed because the retinal breaks were not near the ora serrata, and the subretinal fluid could be aspirated from the primary breaks.

Postoperatively, patients were randomly assigned to the adjustable positioning group or the free positioning group in accordance with a random number table by a statistician (S.X.J.). In the adjustable group, patients were instructed to be in a non-supine positioning during the daytime and fall asleep in a lateral positioning at night. Patients in the free group did not have any positioning limitations (Figure 1). Patients returned for a follow-up visit 1 day, 1 week, 1 month and 3

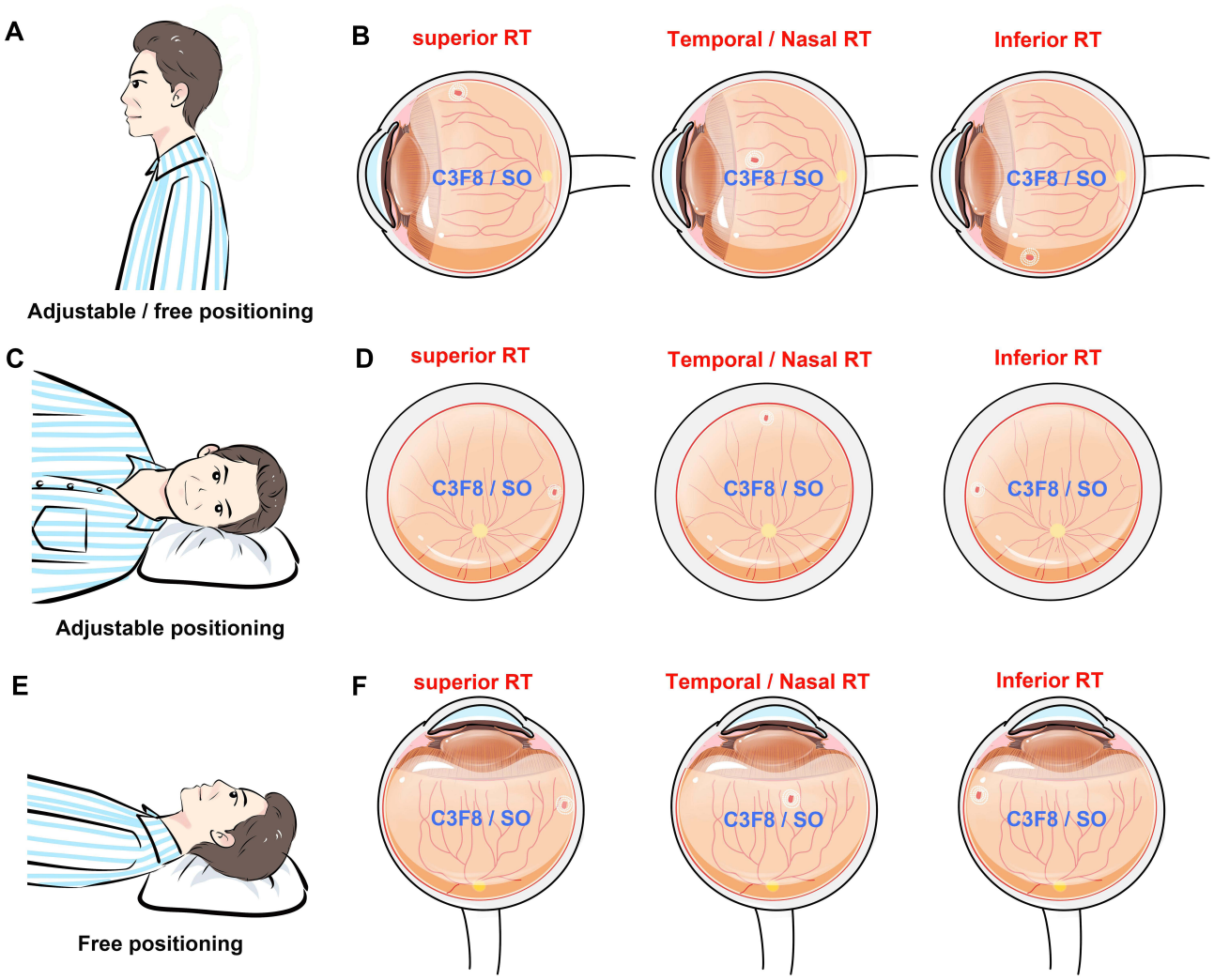

Figure 1 Diagram of retina tear and postoperative positioning. (**A**) Upright positioning in the adjustable or free positioning. (**B**) The location of the superior, temporal/nasal and inferior retina tear (RT) in the upright positioning. (**C**) Lateral positioning in the adjustable positioning. (**D**) The location of the superior, temporal/nasal breaks and inferior RT in the lateral positioning. (**E**) Face-up positioning in the free positioning. (**F**) The location of the superior, temporal/nasal and the inferior RT in the face-up positioning.

months after surgery. Patients with SO tamponade were examined 1 day, 1 week and 1 month additionally after SO extraction.

Statistical analysis was performed with SPSS Statistics 23.0 (SPSS Inc, Chicago, IL, USA). Data were analyzed using the Fisher's exact test for categorical variables and the *t*-test and the Mann–Whitney U test for numerical and ordinal variables. A P-value less than 0.05 was considered statistically significant.

Results

A total of 94 eyes from 94 patients were included in the study. There were 47 eyes in the adjustable group and 47 eyes in the free group. All patients attended timely follow-up examinations. No statistical difference was found in preoperative indicators among the corresponding groups ($P > 0.05$), including age, gender, bilaterality, BCVA, IOP and AL. There were more patients who had retinal detachment involving the two quadrants (61.7% vs 63.9%, $P = 0.898$) and macular detachment (72.3% vs 85.1%, $P = 0.131$) in both groups, but there was no statistical difference between the two groups ($P > 0.05$). The proportion of filling with SO (61.7%, both) or C3F8 (38.3%, both) was the same in both groups. Only a few patients in both groups had to undergo a combined cataract surgery (17.0% vs 14.9%, $P = 0.778$). Preoperative baseline characteristics of patients are shown in Table 1.

Table 1 Preoperative and Intraoperative Baseline Characteristics of the Patients

Date	Adjustable Group (n = 47)	Free Group (n = 47)	*P*
Age, years (mean ± SD)	55.09 ± 9.98	53.53 ± 11.58	0.488
Sex, n (%)			
Female	24 (51.1%)	21 (44.7%)	0.536
Eye, n (%)			
Right	27 (57.4%)	26 (55.3%)	0.835
Preoperative BCVA (logMAR)	1.30 ± 1.02	1.65 ± 1.00	0.09
IOP (mmHg)	12.17 ± 3.41	12.45 ± 3.48	0.689
AL (mm)	25.09 ± 2.08	25.18 ± 2.03	0.834
Vitreous cavity filling n (%)			
Silicone oil	29 (61.7%)	29 (61.7%)	1
Perfluoropropane gas	18 (38.3%)	18 (38.3%)	
Number of break n (%)			
Single	22 (46.8%)	31 (66.0%)	0.061
Multiple	25 (53.2%)	16 (34.0%)	
Location of breaks			
Superior	23	25	0.169
Lateral	15	19	
Inferior	9	3	
Macular status n (%)			
On	13 (27.7%)	7 (14.9%)	0.131
Off	34 (72.3%)	40 (85.1%)	
Retinal breaks closure mode n (%)			
Endophotocoagulation	29 (61.7%)	21 (44.7%)	0.098
Cryopexy	18 (38.3%)	26 (55.3%)	
Combined cataract extraction n (%)	8 (17.0%)	7 (14.9%)	0.778
Involving the quadrant			
1	6(12.8%)	5 (10.6%)	0.898
2	29 (61.7%)	30 (63.9%)	
3	7 (14.9%)	7 (14.9%)	
4	5 (10.6%)	5 (10.6%)	

Abbreviations: BCVA, best-corrected visual acuity; IOP, intraocular pressure; AL, axial length.

The retinal anatomical reattachment after the primary surgery occurred in 46 out of 47 eyes (97.9%) in the adjustable group. Additional scleral buckling surgery was performed in one SO filling eye in the adjustable group, due to PVR causing dehiscence of the primary retinal break 4 weeks after PPV. In the free group, the initial retinal anatomical reattachment was achieved in 45 out of 47 eyes (95.7%), and retinal detachment reoccurred in two eyes. Out of these two eyes, one got retinal detachment recurrence due to PVR three weeks after PPV and SO filling. This eye also accepted additional scleral buckling surgery. SO injection was performed in another eye to restore the retina due to the reopening of the original retinal break two months after PPV combined with C3F8 surgery. In addition, one patient in the free group developed epimacular membrane complication 2 months after surgery and was treated with membrane peeling. No other complications were reported during the follow-up examinations in either group. There was no significant difference in the primary retinal reattachment rate (P = 0.557) between the two groups, and the final retinal reattachment rate was 100% in both groups (Table 2).

There was no significant difference in preoperative BCVA between the two groups, but the final BCVA of patients in the two groups was significantly improved compared with that before surgery, with significant statistical difference ($p < 0.001$), while there was no statistical difference in the final BCVA between the two groups (P = 0.617,). There was no statistical difference in IOP between the two groups 1 day, 1 week, 1 month and 3 months postoperatively (Table 2). IOP in both groups was within the normal range (<21mmHg) at the 1-day follow-up. At the 1-week follow-up, IOP was found

Table 2 Postoperative Characteristics of the Two Groups

	Adjustable Group	Free Group	*P*
Initial retinal reduction rate (%)	97.9 (1/47)	95.7 (2/47)	0.557
Final retinal reduction rate (%)	100	100	1
Postoperative complications	0/47 (0%)	1/47 (2.17%)	0.320
IOP (mmHg)			
Postoperative 1 day	12.44 ± 3.41	13.86 ± 5.45	0.146
Postoperative 1 week	19.67 ± 9.21	22.60 ± 12.27	0.193
Postoperative 1 month	17.88 ± 8.73	20.52 ± 10.24	0.183
Final	15.40 ± 5.48	15.92 ± 4.87	0.633
Final BCVA (logMAR)	0.42 ± 0.44	0.37 ± 0.32	0.617

Table 3 The Comparison of Preoperative and Postoperative

	Adjustable Group			Free Group		
	Preoperative	Postoperative	*p*	Preoperative	Postoperative	*p*
ACD (mm)	3.38 ± 0.50	3.34 ± 0.38	0.586	3.42 ± 0.63	3.39 ± 0.54	0.377
LT (mm)	4.33 ± 0.47	4.38 ± 0.42	0.309	4.26 ± 0.48	4.26 ± 0.35	0.951
BCVA (logMAR)	1.30 ± 1.02	0.42 ± 0.44	<0.001	1.65 ± 1.00	0.37 ± 0.32	<0.001

elevated in 9 eyes (19.1%, 19.67 ± 9.21mmHg) in the adjustable group and in 14 eyes (29.8%, 22.60 ± 12.27mmHg) in the free group. Patients with elevated IOP were treated with anti-glaucoma drugs, and the IOP in both groups returned to normal. Postoperative characteristics of the two groups are shown in Table 2.

There was no statistically significant difference in retinal breaks, macular status and detachment involvement quadrant between the two groups. Intraoperatively, the retinal breaks were treated with endophotocoagulation or cryopexy, Cryotherapy was performed in 18 eyes in the adjustable group and 26 eyes in the free group. There were 29 eyes in the adjustable group and 21 eyes in the free group receiving endophotocoagulation therapy, with no statistical difference (P = 0.098). For patients where cataract was not treated, ACD and LT were reexamined at 1-month follow-up. Paired sample *t*-test showed no statistical difference in ACD and LT before and 1 month after surgery between the adjustable group (ACD: 3.38 ± 0.50 vs 3.34 ± 0.38mm; LT: 4.33 ± 0.47 vs 4.38 ± 0.42mm, P > 0.05) and the free group (ACD: 3.42 ± 0.63mm vs 3.39 ± 0.54mm; LT: 4.26 ± 0.48 vs 4.26 ± 0.35mm, P > 0.05). The ACD and LT are shown in Table 3.

Discussion

Most vitreoretinal surgeons worldwide advised their patients to maintain a face-down positioning for a few weeks after PPV surgery.[14] However, the face-down positioning is not the normal physiological position of the human body, and it can be difficult to maintain such a position for prolonged periods, especially for elders, obese people or people with spinal problems. Surgeons first focused on MH and have found that no imposing the strict face-down positioning after vitrectomy for MH does not reduce the success rate of the surgery.[15–17] In fact, the compliance with the face-down positioning varied considerably among patients who had undergone primary vitrectomy and gas tamponade for MH or RRD.[18] Some patients failed to maintain positioning nearly or more than half the time, with considerable variation among patients and better adherence by female patients, but without associations to the surgery outcome.

Recently, an increasing number of vitreoretinal surgeons have reduced the face-down positioning requirement to improve patient comfort and compliance and avoid potential systemic complications. Chen et al[1] designed a controlled study to address the issue of positioning after PPV for RRD. There was no significant difference in the anatomical success rates, BCVA, and the rates of complications between the face-down group (89.7%) and the adjustable positioning group (92.3%). Martínez Castillo et al[2] achieved a high reattachment rate (94.5%) without performing a prone

positioning in the management of primary pseudophakic RRD due to inferior retinal breaks after PPV with complete drainage of sub-retinal fluid. In the study of Lin et al,[11] adjustable postoperative positioning was found to be effective and safe for RRD repair in different break locations, and the overall primary retinal reattachment rate was 93.3%.

Among recent clinical experience in our hospital,[12] the rate of retinal reattachment was 94.8% in the face-down positioning group and 93.7% in the adjustable positioning group (P = 0.729), and, thus, postoperative positioning does not appear to affect retinal reattachment. Therefore, we further refined our study to compare the effects of free positioning and adjustable positioning after PPV. In this study, the initial retinal reattachment rate of patients in different postoperative positioning in the two groups was 95.7% or above, and the final retinal reattachment rate was 100%, which further demonstrates the safety and effectiveness of the procedure without the need for strict positioning postoperatively. There was no significant difference in the mean postoperative BCVA at 3 months after surgery between the two groups (p = 0.617).

Blocking the retinal breaks is the key to the success of retinal detachment reattachment. In this study, the surgeon mainly used endophotocoagulation or cryopexy after complete liquid–gas exchange without perfluorocarbon to block the retinal breaks, and then filled the vitreous cavity with C3F8 or SO. Previous studies reported that the relationship between the intraoperative subretinal fluid drainage and the gas covering the retinal tears after photocoagulation was a key feature leading to choroidal retinal adhesion.[19] The closure of breaks and the chorioretinal adhesion are affected by surface tension rather than buoyancy, which reduces the liquid–gas interface and helps close the break.[20,21] We infer that as long as the vitreous cavity is filled with gas or SO, the surface tension can keep the surface of the hole dry and prevent liquid from escaping to the subretinal space, independently of the location of the hole. The locations of retinal tears in different positionings are shown in Figure 1. Patients were instructed to maintain an adjustable positioning or free positioning postoperatively, and the observation results showed that the success rate of retinal reattachment did not decrease, confirming the original hypothesis.

Although it is still controversial whether vitrectomy increases the risk of glaucoma, high IOP is common after PPV for RRD.[22] However, in those studies that observed adjustable positioning, there was no statistical difference in IOP changes between the adjustable positioning group and the face-down positioning group.[1–3,11,12] In this study, IOP of most patients returned to normal 1 month postoperatively, and patients with high IOP were treated successfully with anti-glaucoma drugs. There was also no statistical difference in IOP changes between the free positioning group and the adjustable positioning group, indicating that postoperative positioning had little influence on IOP. Although the post-operation IOP was not associated with the position, the anterior chamber depth of patients in the supine position should be paid special attention to reduce the risk of inducing angle-closure glaucoma. For patients with shallow anterior chamber, Nd:YAG laser peripheral iridectomy should be performed before surgery.

Some surgeons believe that failure to maintain a face-down positioning after gas or SO tamponade may lead to a shallow anterior chamber and increased IOP. Others, however, believe that postoperative ACD decrease may be related to the lens-iris diaphragm moving forward due to prone postoperative positioning.[23,24] In this study, there was no statistical difference in ACD and LT between preoperative and postoperative 1 month in both groups. These results suggest that the face-down positioning could cause the ACD decrease, while the adjustable and free positioning do not, and the change in positioning is not related to the increase in IOP.

To the best of our knowledge, this is the first prospective randomized controlled study to compare the safety and efficacy of adjustable and free postoperative positioning after PPV for RRD. However, there are still limitations in our study: First, the study cohort was relatively small. Secondly, this study was not a multicenter study, and more studies are needed to confirm the results. Furthermore, the follow-up time is short, especially for the assessment of ACD and LT.

In summary, this study indicates that the use of free postoperative positioning with PPV for RRD does not reduce the success rate of retinal reattachment and does not increase the chance of complications. Our results may encourage surgeons to reconsider postoperatively positioning and provide patients with an additional postoperatively option to improve compliance and comfort.

Data Sharing Statement

All data relevant to the study are included in the article. The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent Statement

The study was obtained from the approval of Ethics Committee of the Eye Institute of Shandong First Medical University and conducted following the ethical standards presented in the 1964 Declaration of Helsinki and its later amendments. All enrolled patients provided written informed consent.

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Author Contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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Disclosure

All authors: No declared conflicts of interest.

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