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## Research article

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# Clinical observation of short-term on primary pars plana vitrectomy without perfluorocarbon fluids under the wide-angle observation system in treatment rhegmatogenous retinal detachment with PVR $\leq$ C2

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## Abstract

**Background:** To observe the short-term efficacy of vitrectomy for wide-angle observation system without perfluorocarbon liquid (PFCL) in the treatment of rhegmatogenous retinal detachment (RRD) with Proliferative vitreous retinopathy (PVR)  $\leq$  C2.

**Methods:** Retrospective analysis of the case data of patients with rhegmatogenous retinal detachment who did not use or use perfluorocarbon liquid during vitrectomy, including age, sex, course of disease, PVR classification, preoperative and stepwise best corrected positive vision, Perfluorocarbon liquid in the perfluorocarbon liquid group, the reposition state of the retina, the difference in visual acuity recovery and retina reset rate within and between groups.

**Results:** There was no statistically significant difference in baseline data (age, sex, course of disease, PVR grade) between the non-perfluorocarbon liquid group and the perfluorocarbon liquid group ( $P > 0.05$ ). The rate of initial reset at the time of discharge from the non-perfluorocarbon liquid group was 92.9%. The retinal reposition rate at 6 months after surgery was 100%. The rate of initial reduction at discharge was 93.5% in the group using perfluorocarbon liquid, and the final retinal reduction rate at 6 months after surgery was 100%. There was no statistically significant difference in logMAR BCVA of postoperative follow-up time between the two groups ( $P > 0.05$ ). Without the use of perfluorocarbon liquid, there was no postoperative perfluorocarbon liquid residue, and the residual rate of perfluorocarbon liquid in the perfluorocarbon liquid group was 14.5%.

**Conclusion:** Vitrectomy without the use of perfluorocarbon fluids under the wide-angle observation system is the first choice to treat rhegmatogenous retinal detachment with PVR  $\leq$  C2.

**Keywords:** heavy liquid; rhegmatogenous retinal detachment; primary pars plana vitrectomy

## Introduction

Primary Pars Plana Vitrectomy (PPPV) is considered to be the most common and efficiency treatment for Rhegmatogenous Retinal Detachment (RRD). Heavy liquid, or Perfluorocarbon liquid (PFCL), has been widely used in PPV as a liquid operating tool since the 1980s, because of the

characteristics like clear colorless, heavy specific gravity, low viscosity and has specific surface. If failed to forming larger droplets, when injecting PFCL in surgery, the heavy liquid will be residualized during the fluid-air exchange. A number of studies have found the rate of residual heavy liquid was 0.9%~11.1%. Residual heavy liquid needs to be fixed by retinal laser photocoagulation because of the retinal toxicity, even the second operation to remove the heavy liquid under the subfoveal or parafoveal area, which has a certain impact on the patient's prognosis. And these operations may affect the restoration of visual function and increase medical costs.. The best way to avoid residual perfluorocarbon liquid is to avoid it during vitrectomy.

This study included retrospectively RRD patients who underwent PPV surgery without operative use of PFCL in our hospital, compared with the PFCL group, and observed the condition of resuming and effect of operation.

## Methods

Retrospective non-random study. The study adhered to the tenets of the Helsinki Declaration of 1975 as revised in 1983, and the investigation review board of the Changsha Xiangjiang Aier Eye hospital approved the protocol.

The retrospective analysis selected the case data of the first vitrectomy for patients with rhegmatogenous retinal detachment admitted from January 2017 to May 2019 at Xiangjiang Aier Eye Hospital in Changsha. Non-randomly divided into two groups that do not use perfluorocarbon liquid and those that use perfluorocarbon liquid. 71 cases of 71 eyes without perfluorocarbon liquid, including 40 cases of 40 eyes of men and 31 eyes of 31 women; all were monocular, 40 eyes of 40 eyes of right eye, 31 eyes of 31 eyes of left eye; 25 cases of intraocular lens 25 eye. The age is 16 ~ 71 ( $53.18 \pm 15.16$ ) years old. 62 cases with 62 eyes in the perfluorocarbon liquid group, including 41 men with 41 eyes and 21 women with 21 eyes; all were monocular, 30 eyes with 30 eyes in right eye, 32 eyes in 32 eyes with left eye; 19 eyes with 19 intraocular lens eyes . The age is 20 ~ 75 ( $48.68 \pm 12.44$ ) years old. All patients underwent best corrected visual acuity (BCVA), (recorded into logMAR vision), color fundus photography, slit lamp front mirror, optical coherence tomography (OCT) and type B Ultrasound and other examinations. Inclusion criteria: (1) patients diagnosed as rhegmatogenous retinal detachment by slit lamp anterior mirror (+ 90D), OCT and B-ultrasound examination,  $PVR \leq C2$ ; (2) Vitreous hemorrhage was diagnosed at the first diagnosis, orifice was confirmed during surgery For patients with retinal detachment,  $PVR \leq C2$ ; (3) Vitrectomy is the first choice, wide-angle observation system (Resight 700, Germany, Zeiss) is used during the operation, and no perfluorocarbon liquid is used or used during the operation; (4 ) Those who filled with silicone oil took oil 3 months after the operation, followed by at least 3 months after the removal of silicone oil, a total of at least 6 months. Those who filled with filtered air were followed up for at least 6 months. Postoperative exclusion criteria: (1)  $PVR \geq C3$  grade rhegmatogenous retinal detachment; (2) Giant retinal detachment, macular hole retinal detachment alone; (3) Follow-up less than 6 months.

All patients were operated by the same doctor with extensive experience in PPV. They were anesthetized with a mixed solution of 2% lidocaine and 0.75% ropivacaine (3: 5) after the injection of the ball, and a 23G vitrectomy system (Geuder , Germany) for vitrectomy. The main steps are as follows: 1) Establish three channels of sclera 3.5-4mm from the limbus. Cataract surgery is performed on those with severe cataracts. 2) Resight wide-angle lens excision of the anterior and central area of the vitreous, after treatment of the posterior pole retina, do not use or use

perfluorocarbon liquid to fix the posterior pole retina and excise the peripheral vitreous. 3) Gas-liquid exchange until the retina is flat. If there is no fluorocarbon liquid in the upper retinal detachment, there will be more subretinal effusion after gas-liquid exchange. 4) After careful inspection, laser photocoagulation (IRIDEX, USA, semiconductor 532 laser) is performed on the retinal hole and retinal degeneration area. 5) Fill the vitreous cavity with filtered air or silicone oil. 6) Pull out the sleeve and close the incision if necessary. Postoperative patients were given face-down or lateral lying positions for 1-2 weeks, insisting on 6-8 hours per day, and were treated locally with anti-infection and anti-inflammatory treatment. They were discharged after 3 days of observation, 1 week, 1 month, 3 days after surgery. The patients were followed up for BCVA, OCT and fundus examination in the operation month, 4 months and 6 months to observe the visual acuity (BCVA) and retinal reposition. The data was processed using SPSS 21.0 statistical analysis software, and logMAR BCVA before and after treatment was expressed as mean  $\pm$  standard deviation ( $\bar{X} \pm s$ ). Before and after the logMAR BCVA analysis of variance using repeated measurements data.  $P < 0.05$  has statistical significance.

## Results

There was no statistical difference in gender, age, eye classification, course of disease, and PVR grade between the two groups using the perfluorocarbon liquid group and the non-perfluorocarbon liquid group, as shown in Table 1.

		PFCL	Without PFCL	P
Gender	Male	41	40	0.248
	Female	21	31	
Eye	Right	30	40	0.36
	Left	32	31	
Age (years old)		48.68 $\pm$ 12.4	53.2 $\pm$ 15.2	0.66
Course of disease(day)		130.2 $\pm$ 320.5	119.8 $\pm$ 296.7	0.847
PVR (eyes)	A	20	16	0.128
	B	37	45	
	C1	4	6	
	C2	1	4	

Note: Chi-square test was used for gender and eye classification; single-factor analysis of variance was used for age and disease duration; two independent sample t tests were used for PVR classification.

Retinal hole: 71 eyes of 71 cases included in the group without perfluorocarbon liquid: 49 eyes above the temporal, 31 eyes below the temporal, 8 eyes below the nose, 17 eyes above the nose, 25 eyes with macular hole, including multiple. There were 23 eyes with more than 2 or more quadrants. Of the 62 cases of 62 eyes included in the perfluorocarbon liquid group, 35 eyes above the temporal,

20 eyes below the temporal, 13 eyes below the nose, 19 eyes above the nose, 10 eyes with macular hole, including multiple holes more than 2 and 2 There are 20 eyes in more than four quadrants.

22 cases and 22 eyes were filled with filtered air without perfluorocarbon liquid group, including 5 cases and 5 eyes with cataract phacoemulsification and intraocular lens implantation, and 1 case was treated with intravitreal gas injection again. 49 cases were filled with silicone oil and 49 eyes, including 16 cases combined with cataract phacoemulsification and intraocular lens implantation, and all the intraocular silicone oils were removed 3 months after PPV. Intraocular lens implantation was performed, in which 4 cases were filled with filtered air after taking oil due to the presence of fluid accumulation under the retina. There were 19 patients with postoperative high intraocular pressure (26 ~ 48mmHg), and 11 patients occurred within 1 week after surgery. After treatment with anti-glaucoma drugs, all patients returned to normal within 2 weeks.

10 cases and 10 eyes were filled with filtered air using perfluorocarbon liquid group, including 3 cases and 3 eyes with cataract phacoemulsification and intraocular lens implantation. 52 cases of 52 eyes were filled with silicone oil, of which 20 cases were combined with cataract phacoemulsification and intraocular lens implantation, and the intraocular silicone oil was removed 3 months after PPV. And intraocular lens implantation. There were 21 patients with postoperative high intraocular pressure (30 ~ 62mmHg), and 17 patients occurred within 1 week after surgery. After treatment with anti-glaucoma drugs, all patients returned to normal within 2 weeks.

The incidence of iatrogenic fractures: 18 of 71 eyes that did not use the perfluorocarbon liquid group had iatrogenic fractures during surgery. The incidence of pores was 25.7% and the number of pores was  $0.39 \pm 0.78$ . 15 of 62 eyes in the perfluorocarbon liquid group had iatrogenic fractures, the incidence rate was 24.2%, the number of pores was  $0.37 \pm 0.73$  (pieces), and there was no statistically significant difference between the two groups ( $F = 0.31, P = 0.859$ ). As shown in table 2.

Table 2 Comparison of two cases of iatrogenic fractures

	Number of eyes	Number of holes	F	P
PFCL	15	$0.39 \pm 0.78$	0.31	0.859
Without PFCL	18	$0.37 \pm 0.73$		

Note: The two groups of iatrogenic fractures were compared by single factor analysis of variance, and the number of fractures was expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ).

Perfluorocarbon liquid residual rate: There was no occurrence in the non-perfluorocarbon liquid group, 9 cases in the perfluorocarbon liquid group, 2 cases occurred in the posterior pole, and the rest were located under the middle and peripheral parts of the retina. .

66 cases of 71 eyes not using perfluorocarbon liquid after the first PPV operation, the retinal detachment was successfully reset, and the initial reset rate was 92.9%. Of the 62 eyes using the perfluorocarbon liquid group, 58 eyes had successful omentum reposition after the first PPV operation, and the initial reduction rate was 93.5%. The retinal detachment of all patients in both groups was flat in place at 6 months after surgery, and the final retinal reposition rate was 100%.

There was no statistical difference between LogMAR BCVA at each time point between the two groups without using the perfluorocarbon liquid group and the using perfluorocarbon liquid group ( $p > 0.05$ ). Comparison between the two groups before and after self-control, logMAR BCVA before

operation and logMAR BCVA 1 week after operation, logMAR BCVA 6 months after operation, the difference was statistically significant ( $p = 0.000$ ). As shown in Figure 1 and Table 3.

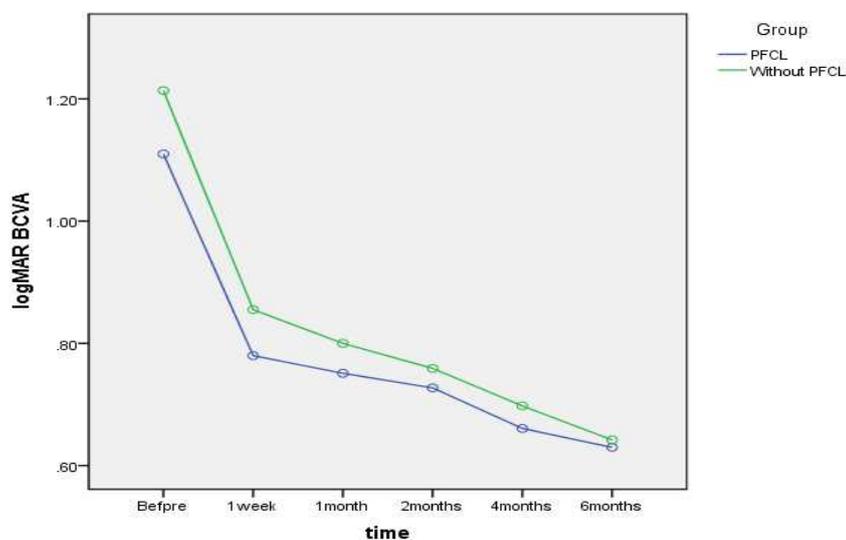


Figure 1 Trend graph of two groups of logMAR BCVA over time

Table 3 Two groups of logMAR BCVA results at different time points

	PFCL	Without PFCL	F	P
Before	1.11±0.63	1.21±0.64	0.877	0.351
1 week	0.78±0.46	0.86±0.45	0.903	0.344
1 month	0.75±0.45	0.80±0.38	0.461	0.498
2 months	0.73±0.48	0.76±0.39	0.178	0.674
4 months	0.66±0.51	0.70±0.41	0.210	0.647
6 months	0.63±0.49	0.64±0.42	0.023	0.879
F	8.204	14.318		
P	0.000	0.000		

Note: Two-factor repeated measures analysis of variance was used to compare two groups of logMAR BCVA at different time points

## Discussion

The treatment methods for rhegmatogenous retinal detachment include external scleral buckling or (and) internal vitrectomy retinal reposition. For simple cases, external route is generally selected, and for complex cases, internal (or combined) external surgery can only be selected. With the increasing maturity of vitreoretinal surgery systems and techniques, for simple and more complex cases, the proportion of vitrectomy is increasing. The study found that vitrectomy is the preferred method for retinal reduction than scleral buckling, and the reoperation rate of patients with vitrectomy is also lower than scleral buckling [1]. Among patients with more complicated retinal detachment in intraocular lens, vitrectomy combined with scleral buckling is the best choice [2]. With intraocular lens, vitreous opacity, and proliferative vitreoretinopathy, vitrectomy has advantages over scleral buckling [3]. Vitrectomy and scleral buckling of the wide-angle observation system are more effective than scleral buckling for vitrectomy using the wide-angle observation system [4]. In addition, while improving the success rate of retinal reposition, the visual quality of

postoperative eyes has also received attention. Scleral buckling surgery will change the eye axis, corneal thickness, and other important refractive factors of the eye due to the external pressure of the closed eye. Other studies have shown that scleral buckling can lead to lens-iris septum advancement, anterior chamber shallowing, anterior ciliary body transposition, and narrowing of anterior chamber angle. The Resight wide-angle observation system has the characteristics of wide observation range, no deformation of the peripheral part, saving operation time and so on. Therefore, in this study, the Resight wide-angle observation system underwent vitrectomy for rhegmatogenous retinal detachment was preferred for both groups of cases.

PFCL is a synthetic fluorinated liquid containing a carbon-fluorine bond with a specific gravity in the range of 1.76-2.03<sup>[5]</sup>. Vitrectomy can be used to fix the retinal detachment of the posterior pole, reducing the possibility of iatrogenic retinal holes due to retinal drift during vitrectomy<sup>[6]</sup>. PFCL can also be used to reverse the posterior edge of the detached hole in giant retinal detachment. The perfluorocarbon liquid is discharged from the subretinal fluid of the posterior pole, and the laser photocoagulation is clearly observed when it reaches the trailing edge of the hole. Laser spot. However, with the implementation of minimally invasive vitrectomy, except for the conventional causes of perfluorocarbon liquid entering the retina and causing postoperative residuals, the upper two incisions of the effluent may be too small, and there is an autism system, the injection needle is too thin, and the injection Excessive speed results in residual PFCL under the retina. The study found that after 7 days of human retinal pigment epithelial cells exposed to perfluorocarbon liquid, the cell survival rate decreased significantly<sup>[7]</sup>. Stolba et al.<sup>[8]</sup> studied the effect of PFCL of different purity on the retina and found that high-purity PFCL can cause a decrease in the number of cells in the outer plexiform layer and inner and outer nuclear layer of the retina. Outer layer of retinal folds, reduced number of nuclei and pathological hypertrophy of Müller cells, etc., even the irregular structure of the whole layer of the retina, reduced number of photoreceptor cells, etc.

The toxic effect of perfluorocarbon liquids on ocular tissues may be caused by the following reasons: high specific gravity mechanical compression causes tissue malnutrition<sup>[7]</sup>, impurities generated when insufficient fluorination damages the tissue<sup>[9-14]</sup>, PFCL cannot dissolve ions, Cause tissue metabolic disorders<sup>[15]</sup>. Among them, because of the different PFCL testing standards and methods of the production batches of various companies, the impurities contained are different. Therefore, most experts and scholars still recommend that all operations should be removed as far as possible, and the residual perfluorocarbon liquid should also be removed as soon as possible. Taking into account the damage to the eye tissue caused by the residual perfluorocarbon liquid and the decrease of the patient's visual function and the increase of the economic burden caused by the removal of the residual perfluorocarbon liquid, the increase in the difficulty of the doctor's operation and other reasons have gradually appeared in recent years. A study on the use of perfluorocarbon fluid vitrectomy for rhegmatogenous retinal detachment. Neuhann et al.<sup>[16]</sup> followed up and observed 79 patients with rhegmatogenous retinal detachment who had undergone vitrectomy (without using perfluorocarbon liquid and the intraocular filling was a mixture of SF<sub>6</sub>, C<sub>2</sub>F<sub>6</sub> and C<sub>3</sub>F<sub>8</sub>). In all cases, the first anatomical reduction rate was 71%, the detachment rate was 19%, and the final retinal reduction rate was 100%. Neuhann et al. Believe that although the use of perfluorocarbon liquids during surgery avoids the possible disadvantages of postoperative residuals and saves potential economic costs, it reduces the anatomical reduction rate of the retina, so it is recommended to use this only in specific cases. Surgical approach. In our non-perfluorocarbon liquid group and the perfluorocarbon liquid group, there was no statistical difference between the rate of retinal

anatomical reduction at discharge and the retinal anatomical reduction rate at 6 months. Our anatomical reduction rate at discharge was higher than the above studies, possibly due to the lack of inflation gas on the market and the high number of cases filled with silicone oil. Lin Z, Liang QH et al. [17] followed up 36 cases of patients with rhegmatogenous retinal detachment who underwent vitrectomy (no perfluorocarbon liquid was used during the operation and the intraocular filling was air). The initial reduction rate was 94.4%, so it believes that the rate of retinal reattachment of vitrectomy for rhegmatogenous retinal detachment without heavy water is comparable to traditional surgery.

A total of 71 patients were included in the non-perfluorocarbon liquid group in this study, the observation time was 6 months after surgery, and in this study, the location of the retinal hole covered all regions of the retina and included multiple holes, follow-up found There were significant differences in BCVA before and after surgery. Postoperative BCVA was higher than before surgery. The initial retinal reposition rate was 92.9%, and the final retinal reposition rate was 100%. There was no recurrence of retinal detachment. Therefore, we believe that vitrectomy without perfluorocarbon liquid is the first choice for more complicated rhegmatogenous retinal detachment, which can improve the patient's vision to a certain extent while obtaining a good retinal reposition rate, and effectively avoid the residual risk of PFCL .

The causes of iatrogenic holes in vitrectomy include indirect damage and direct injury caused by iatrogenic holes. Indirect damage includes surgical incision, away from the surgical incision, excessive pulling of the vitreous traction by the person who detached after the vitreous, and direct damage includes the process of vitrectomy The detached retinal incarcerated, directly damage the retina during vitrectomy, and occur when dealing with hyperplastic membrane and vascular membrane. The surgeons in this study had extensive experience in vitrectomy, and the direct injury such as indirect injury and peeling caused a relatively low probability of iatrogenic retinal holes. Therefore, we only counted the occurrence of iatrogenic holes caused by the removal of the peripheral detachment of the retina related to the use of perfluorocarbon liquid. Its main risk factors are incorrect parameters of vitrectomy, excessive cutting speed, excessive suction and spherical retinal detachment. The perfluorocarbon liquid is used to fix the posterior pole retina during the operation, and the minimally invasive vitrectomy system uses high cutting speed and low suction to remove the peripheral vitreous and other methods can reduce the occurrence of intraoperative iatrogenic holes. Taking into account the characteristics of 25G equipment is too soft, too low efficiency, etc., all of our research uses 23G glass cutting equipment. The rate of resection of the peripheral part of the group without the use of perfluorocarbon liquid is 3000 times / min, and the suction power is 80 ~ 100mmHg, which is faster than the rate of using the perfluorocarbon liquid group (2000 ~ 2600 times / minute). (100 ~ 150mmHg) less. With the help of light guide fibers to push away the detached retina, the assistant of the wide-angle lens observation system can reduce the incidence of iatrogenic holes without particularly large pressure. There was no statistical difference in the number of iatrogenic retinal holes in vitrectomy between the two groups, indicating that it is safe to perform the surgery without using perfluorocarbon fluids. Considering that the subretinal fluid discharge may not be complete in the group without using perfluorocarbon liquid, which affects the reduction rate of surgery. If there is detachment of the upper retina, we use the method of making the upper equator posterior retinal hole, which is conducive to full filling of the vitreous cavity and promoting Posterior retina reset. With macular holes or retinal detachment below the hole, the subretinal fluid is relatively easy to drain. The perfluorocarbon liquid group is used,

because the fixation of the posterior pole retina with heavy water is conducive to gas-liquid exchange, and the subretinal fluid is discharged relatively completely. Because both cases use the Resight wide-angle observation system, the observation range is wide, which is convenient for gas-liquid exchange, and the subretinal fluid discharge is relatively complete, so the efficacy is relatively comparable.

The shortcoming of this study is that the two groups of cases are filled with silicone oil, the number of cases is shorter, the observation time is shorter, and the number of cases in the control group is less.

## **Conclusion**

Vitreotomy without the use of perfluorocarbon fluids under the wide-angle observation system is the first choice to treat rhegmatogenous retinal detachment with PVR $\leq$ C2.

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# Figures

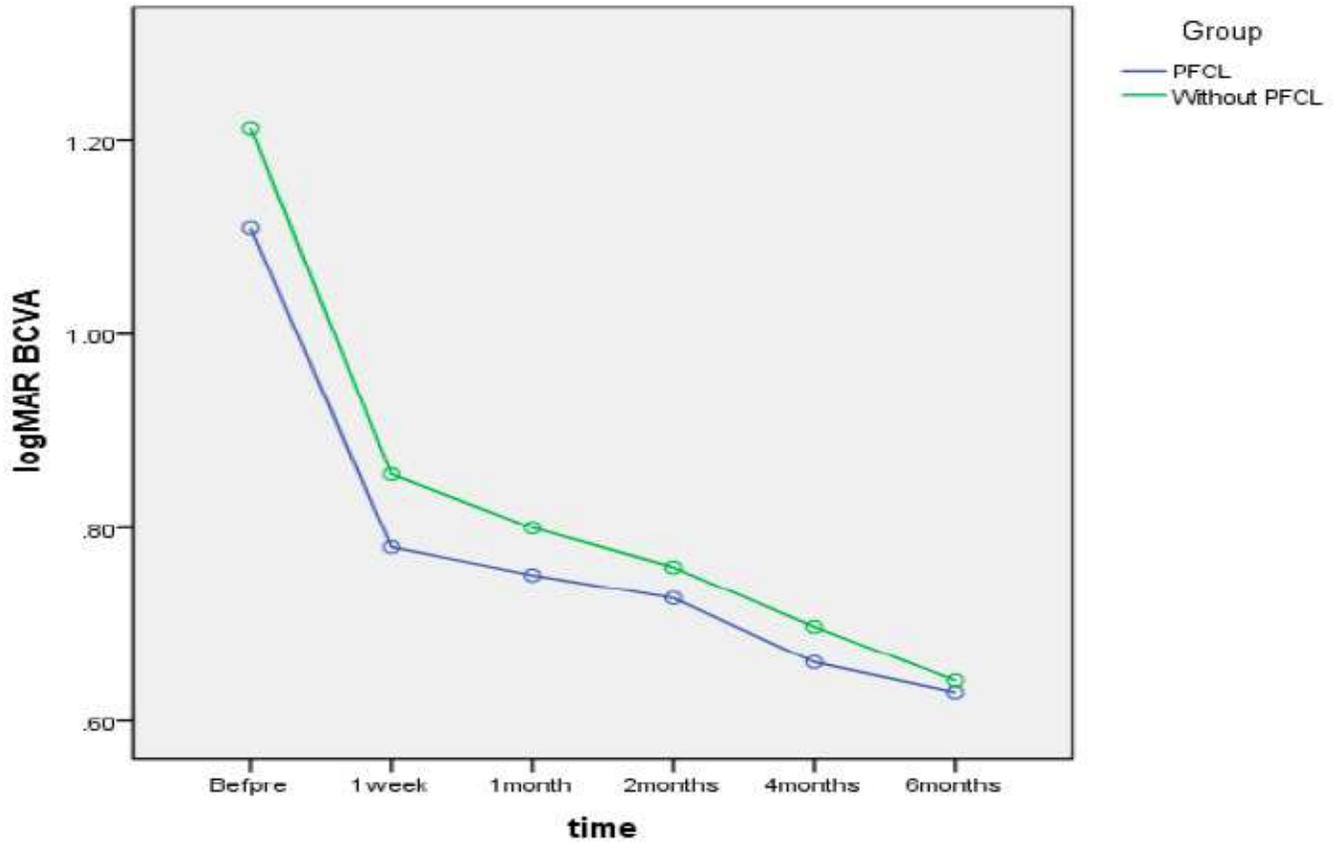


Figure 1

Trend graph of two groups of logMAR BCVA over time