Original Article

Intraocular Pressure Changes Following Pars Plana Vitrectomy with 1000 CST and 5000 CST Silicone Oil in Superior Rhegmatogenous Retinal Detachment: A Comparative Study

PJO – Official Journal of Ophthalmological Society of Pakistan

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ABSTRACT

Purpose: To compare mean IOP changes following PPV using 1000 CST and 5000 CST silicone oil in patients with superior Rhegmatogenous Retinal Detachment (RRD).

Study Design: Quasi experimental study.

Place and Duration of Study: Layton Rahmatullah Benevolent Trust (LRBT) from January 2024 to June 2024.

Methods: A total of 150 patients with age range of 21 to 70 years, diagnosed with superior rhegmatogenous retinal detachment (RRD) and proliferative vitreoretinopathy (PVR) of grade B or C, were recruited. They were divided into two groups; Group A underwent vitrectomy with 1000 centistokes (cSt) and Group B had 5000 cSt silicone oil as tamponade. Intraocular pressure (IOP) was measured before and at 6, 12, 24, and 48 hours after surgery. Independent sample t-test was used to compare the results with p-value of ≤0.05 as significant.

Results: The mean age was comparable between the two groups (Group A: 44.64 ± 14.71 years; Group B: 44.76 ± 14.09 years). A postoperative increase in IOP was observed in both groups. However, at 24 and 48 hours, Group B demonstrated significantly higher IOP compared to Group A, with mean values of 19.34 ± 0.86 vs. 18.64 ± 0.61 mmHg (p = 0.001) and 19.70 ± 1.09 vs. 19.22 ± 0.92 mmHg (p = 0.004), respectively.

Conclusion: Both 1000 cSt and 5000 cSt silicone oil leads to IOP elevation after PPV, but the increase is more significant and sustained in the 5000 cSt group. Careful IOP monitoring is recommended, especially in patients receiving high-viscosity silicone oil.

Keywords: Rhegmatogenous Retinal Detachment, Pars Plana Vitrectomy, Silicone Oil, Intraocular Pressure, Viscosity.

How to Cite this Article: Manzoor MU, Iqbal K, Rehman FU, Manzoor M, Rehman S. Intraocular Pressure Changes Following Pars Plana Vitrectomy with 1000 CST and 5000 CST Silicone Oil in Superior Rhegmatogenous Retinal Detachment: A Comparative Study. 2026;42(1):1-6. **Doi: 10.36351/pjo.v42i1.2105**

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Received: May 09, 2025
Revised: October 31, 2025
Accepted: December 23, 2025

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) is a sight-threatening condition requiring surgical intervention either with pars plana vitrectomy (PPV) using internal tamponade or scleral buckling.[1-2] Silicone oil provides excellent internal tamponade particularly in cases complicated by proliferative vitreoretinopathy or giant retinal tears.[3-4] Despite its effectiveness, postoperative elevation of intraocular pressure (IOP) represents one of the most frequently encountered complications

following silicone oil tamponade, with reported incidence ranging from 3% to 30% in different studies.[5-6]

The IOP of silicone oil filled eye increases through various mechanisms, presenting as either ocular hypertension or glaucoma.[7]Numerous factors have been recognized as contributing to the elevation of IOP, such as the rheological properties of silicone oil, elevated preoperative IOP, diabetes mellitus, and the condition of the lens. Silicone oils with lower viscosities (e.g., 1000 cSt) have a tendency to undergo emulsification at a faster rate, potentially resulting in the formation of microdroplets that could impede the drainage of aqueous humor and obstruct trabecular meshwork, thereby fostering an increase in IOP levels.[8] In contrast, higher viscosity oils (5000 cSt) demonstrate enhanced biocompatibility and greater resistance to emulsification, which has led many surgeons to prefer them for complex RRD cases requiring long-term tamponade.[9,10] Despite their theoretical advantages, 5000 cSt silicone oil has been reported to cause significantly higher IOP compared to baseline at day 1, 1 month, 4 months, and one year post-surgery.[11] A significantly higher IOP has been recorded with 5000 cSt when compared with 1000 cSt oil.[12] Several factors, including axial length and pre-removal IOP, have been associated with the persistence of residual silicone oil droplets, which may in turn contribute to elevated IOP.[13-14]

There are other factors which may contribute to IOP elevation, including surgery-induced intraocular inflammation, long-term corticosteroid use, and specific surgical techniques such as pan retinal photocoagulation combined with silicone oil tamponade.[15] Recent progress in surgical methodologies and medical procedures, such as the implementation of inferior peripheral iridectomy and meticulous postoperative positioning, have played a significant role in enhancing patient outcomes and minimizing adverse effects.[16] To understand these factors, which cause IOP changes with different viscosity oils warrant further investigation. This research was planned to analyze IOP changes after PPV with 1000 cSt versus 5000 cSt silicone oil, with a specific focus on individuals diagnosed with superior rhegmatogenous retinal detachment.

METHODS

The Institutional Review board approved the study **(No.2/Admn/Ex-Cer/LRBT-2025)**. The sample size was determined using a 95% confidence level, 90% test power, and expected mean intraocular pressure (IOP) of 16.27 ± 4.19 mmHg for the 5000 cSt silicone oil group and 13.67 ± 3.24 mmHg for the 1000 cSt group.[17] A total of 150 patients were enrolled and evenly allocated between the two groups. The study was conducted from January 2024 to June 2024. Written informed consent was obtained from all participants prior to enrollment. Eligible patients were adults aged 21–70 years presenting with rhegmatogenous retinal detachment (RD) involving the superior quadrants, associated with proliferative vitreoretinopathy (PVR) grades B or C. Patients were admitted to LRBT and allocated by convenient sampling either to Group A which received 1000 cSt silicon oil or Group B which had 5000 centistokes (cSt) silicone oil after PPV. Patients with history of ocular surgery, pre-existing glaucoma, intraocular inflammation, traumatic RD, intraocular foreign bodies, aphakia, pre-existing retinopathy, or failure to achieve retinal reattachment during surgery were excluded.

Every patient underwent complete history and ocular examination including IOP using Applanation tonometer, pupillary reflexes, slit lamp examination and fundoscopy. The patients were operated on by a single experienced surgeon under either general or local anesthesia, with retinectomy as deemed necessary. Topical Moxifloxacin 0.5% and Dexamethasone 0.1% were prescribed every two hours for the first week and gradually tapered over eight weeks. Ciprofloxacin 500 mg (every 12 hours) and Ibuprofen 200 mg (every 8 hours) were administered for the initial three postoperative days. IOP was monitored by the same observer at each follow up. Silicone oil emulsification was defined as pseudo-hypopyon greater than 1 mm on slit lamp examination.

The data was analyzed using IBM SPSS version 25.0. Continuous variables, such as age and IOP, were reported as mean with standard deviations. Categorical variables, including gender, PVR grade, and eye laterality, were presented as frequencies and percentages. The normality of data was assessed by using Shapiro-Wilk test. The primary objective was IOP rise after surgery in both groups and their comparison. Independent sample t-test was used for comparing baseline, 6 hours, 12 hours, 24 hours, and 48 hours IOP after surgery between the two groups.

RESULTS

Distribution of key demographic and clinical variables in study participants is shown in Table 1. The mean age in Group A was 44.64 ± 14.71 years, and in Group B, it was 44.76 ± 14.09 years. Table 2 compares mean IOP at different postoperative intervals between the two groups. At baseline, Group A had a significantly higher IOP than Group B. Both groups showed a postoperative rise in IOP at 6 and 12 hours, though without significant intergroup differences. By 24 and 48 hours, however, Group B demonstrated significantly higher IOP values, indicating a more sustained elevation in the 5000 cSt group.

Repeated measures ANOVA demonstrated a significant main effect of time on IOP ($p < .001$), but no significant main effect of group ($p = .274$). A significant time–group interaction ($p = .004$) indicated that the trajectory of IOP changes differed between the 1000 cSt and 5000 cSt groups (Table 3). Figure 1 shows trend of IOP following 1000 cSt versus 5000 cSt on follow ups.

Table-1: *Comparison of distribution of different variables between groups.*

Variables		Groups	
		Group-A (1000 cSt)	Group-B (5000 cSt)
Gender	Male	40(53.3%)	39(52.0%)
	Female	35(46.7%)	36(48.0%)
Age(years)	Mean±SD	44.64±14.71	44.76±14.09
PVR grade	Grade-B	43(57.3%)	42(56.0%)
	Grade-C	32(42.7%)	33(44.0%)
Laterality	Right	34(45.3%)	33(44.0%)
	Left	41(54.7%)	42(56.0%)

Table-2: *Comparison of mean IOP at different intervals between groups.*

Mean IOP at different intervals	Groups		p-value
	Group-A (1000 cSt)	Group-B (5000 cSt)	
Baseline IOP	15.30±2.10	14.57±1.95	0.030
IOP at 6 hours	17.51±2.13	17.67±2.15	0.662
IOP at 12 hours	18.50±2.72	19.02±2.38	0.216
IOP at 24 hours	18.64±0.61	19.34±0.86	0.001
IOP at 48 hours	19.22±0.92	19.70±1.09	0.004

Table-3: *Repeated Measures ANOVA Results for Intraocular Pressure (IOP) Across Time and Groups.*

Effect	df	F	p	Partial η²
Within-Subjects Effects				
Time (Greenhouse-Geisser)	2.19, 323.43	221.33	< .001	0.599
Time × Group (Greenhouse-Geisser)	2.19, 323.43	5.39	0.004	0.035
Between-Subjects Effect				
Group	1, 148	1.21	0.274	0.008

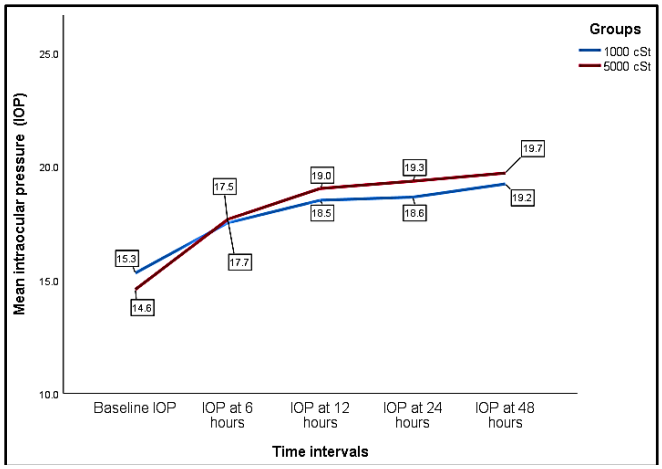

Figure-1: Trend of IOP following 1000 cSt versus 5000 cSt on subsequent follow ups.

DISCUSSION

This study compared intraocular pressure changes following pars plana vitrectomy using 1000 cSt versus 5000 cSt silicone oil in patients with RRD involving superior retina. The results demonstrate that while both viscosities led to postoperative IOP elevation, patients receiving 5000 cSt silicone oil experienced more significant and sustained pressure rise at 24- and 48-hours post-surgery compared to those receiving 1000 cSt oil. This pattern of IOP elevation aligns with previous research.[6,7] Amany et al, reported that peak IOP elevation occurred in the early postoperative period, with the highest values observed at two weeks, in contrast to the 48-hour peak noted in our study.[18] This might be because of our early and more frequent follow up.

The significant difference in IOP between the two viscosity groups at 24 and 48 hours is particularly noteworthy. The difference of IOP between the two silicone oil groups on the first post-operative day is also reported by another study.[13] However, our study found a more modest but still significant difference of 0.7 mmHg at 24 hours. This smaller difference could

be due to our more homogeneous patient selection, focusing exclusively on RRD with superior quadrant involvement with specific PVR grades.

The mechanisms underlying the greater IOP elevation with higher viscosity silicone oil remain incompletely understood. Traditionally, lower viscosity oils have been associated with higher rates of emulsification and subsequent IOP elevation.[12] However, our findings contradict this assumption in the immediate postoperative period. It is also believed that higher viscosity oils may cause greater anterior chamber angle displacement in the early postoperative period due to their greater buoyancy and resistance to outflow.[19] Singh et al, proposed that immediate postoperative IOP elevation with higher viscosity oils may relate to their greater expansile properties when warmed to body temperature.[12]

The clinical implications of our findings are significant. While the difference in IOP values between groups (0.7 mmHg at 24 hours and 0.48 mmHg at 48 hours) might appear modest, even small, sustained elevations in pressure can potentially impact visual outcomes and increase the risk of glaucomatous damage, particularly in compromised eyes. Our results support Aras et al's recommendation for more vigilant IOP monitoring in patients receiving higher viscosity silicone oil, especially during the first 48 hours.[9]

Despite starting with significantly lower baseline IOP, the 5000 cSt group ultimately developed higher postoperative pressures. This suggests that preoperative IOP may not be a reliable predictor of postoperative IOP when different viscosity oils are used, contradicting some previous studies that identified baseline IOP as a risk factor for postoperative elevation.[20]

Our study has several strengths, including its prospective design, standardized surgical technique by a single surgeon, and precise early postoperative IOP measurements. However, limitations include relatively short follow-up periods. This study did not evaluate other factors that might influence IOP, such as anterior chamber inflammation or anatomical changes in the drainage angle.

Future research should extend the follow-up period to determine if the observed differences persist over extended period of time and whether they translate to clinically significant outcomes such as glaucoma development or visual function. Studies incorporating anterior segment OCT or gonioscopy can elucidate the anatomical mechanisms underlying the viscosity-dependent IOP differences.

CONCLUSION

Both 1000 cSt and 5000 cSt silicone oil leads to postoperative IOP elevation after PPV, but the increase is more significant and sustained in the 5000 cSt group. Careful IOP monitoring is recommended, especially in patients receiving high-viscosity silicone oil.

Funding: This study was not funded by any organization.

Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(No.2/Admn/Ex-Cer/LRBT-2025)**.

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Authors Designation and Contribution

Muhammad Usama Manzoor; Vitreo retinal Resident: *Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

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Muhammad Manzoor; Professor: *Literature Search, Data Acquisition, Manuscript Preparation.*

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