

# Intraocular Pressure Elevation within Six Days After Vitreoretinal Surgery with Silicone Oil Injection for Rhegmatogenous Retinal Detachment

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## Research article

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# Abstract

**Background:** We investigated the incidence of and risk factors for intraocular pressure elevation within 6 days following pars plana vitrectomy with silicone oil injection for rhegmatogenous retinal detachment.

**Methods:** We reviewed the records of 55 patients in whom pars plana vitrectomy with silicone oil injection was performed. The intraocular pressure was evaluated before surgery and 1 day, 3 days, and 6 days post-operatively.

**Results:** Intraocular pressure elevation was found in 49% of eyes within 6 days after surgery. A long duration of rhegmatogenous retinal detachment was significantly associated with intraocular pressure elevation on day 1 after surgery. Presence of diabetes was significantly associated with intraocular pressure elevation at 3 days post-operation. Intraocular pressure elevation may occur 6 days following topical steroid use.

**Conclusions:** Intraocular pressure should be monitored regularly in the early post-operative period after pars plana vitrectomy with silicone oil injection for rhegmatogenous retinal detachment, especially in patients with prolonged detachment and diabetic history.

## Background

Recently, there has been a growing trend toward pars plana vitrectomy (PPV) for the treatment of rhegmatogenous retinal detachment (RRD), with rapid advances in instrumentation and improved success rates of vitrectomy [1,2]. PPV with silicone oil (SO) injection appears to be a safe and efficient surgical approach for the management of RRD [3].

Intraocular pressure (IOP) elevation may lead to severe loss of vision and should be closely monitored [4]. Kentaro Yamamoto et al. [5] showed that patients treated for RRD were at high risk for late-onset IOP elevation. Only a few studies have tried to evaluate incidences for early post-operative IOP elevation within 24 hours after PPV and gas tamponade or oil tamponade for RRD [6]. Literature is also scarce regarding risk factors for the development of elevated IOP following PPV and SO injection for RRD. Therefore, the purpose of our study was to determine the incidence of ocular hypertension and the risk factors for IOP elevation within 6 days following PPV with SO injection for RRD.

## Methods

### *Patient Data*

For this retrospective study, we selected all patients who underwent PPV and SO injection for RRD from November 01, 2016 to November 30, 2019 at our department. A retrospective analysis was performed on all eyes that underwent 23-gauge PPV for RRD with SO injection.

### *Inclusion and Exclusion Criteria*

Inclusion criteria included patients who were aged 18 years or older, those having a diagnosis of RRD, and the ability due to undergo PPV and SO injection for repair of retinal detachment.

Exclusion criteria included patients with a preoperative diagnosis of glaucoma, ocular hypertension, or another ocular disease that could alter IOP. Patients with RRD resulting from a macular hole or ocular trauma were also excluded.

### *Data Collection*

Fifty-five patients underwent PPV and SO injection for RRD. Data of the last pre-operative visit and post-operative follow-up data on days 1, 3, and 6 were collected.

### *Surgical Technique*

All surgical procedures were performed under local retrobulbar anesthesia by the same surgeon (L.K. X.).

Standard 3-port PPV was performed with 23-gauge instruments with a complete vitrectomy. The posterior retina was flattened with perfluorocarbon liquid. Then an air–fluid exchange with internal drainage of subretinal fluid. Retinopexy was achieved by laser coagulation. At the end of the procedure, air was exchanged with SO 5,000 centistokes. IOP at the end of surgery was adjusted to  $15.0 \pm 3.0$  mmHg.

Four drops of each the topical steroids and the antibiotics were administered to all eyes daily and progressively tapered over a period of 4 weeks after surgery.

### *IOP Measurement*

IOP was measured using a full auto tonometer (TX-F, Canon, Japan) in the preoperative period, on the first post-operative morning, and at 3 days and 6 days after surgery. An IOP  $\geq 25$  mmHg at any time during the post-operative period was considered IOP elevation. When the IOP was elevated during the post-operative period, antiglaucomatous medications were employed.

### *Statistical Analyses*

Statistical analyses were performed with IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY). Summary statistics included mean and standard deviation (SD) where appropriate. Categorical data were presented as percentages. A subset comparison was performed to analyze the differences between the operated and non-operated fellow eyes in the pre-operative periods using paired t-tests. Multivariable linear regression was used to assess the risk factors for postoperative IOP elevation. *P*-values  $< 0.05$  were considered statistically significant.

## **Results**

A total of 55 eyes of 55 patients who underwent PPV and SO injection to treat RRD were recruited to this study. Pre-operative characteristics are shown in Table 1.

The study displayed the differences in the mean pre-operative IOP and the mean IOP on the first post-operative morning for the operated and non-operated eyes. For the operated eyes, the mean pre-operative IOP and the mean post-operative IOP were 11.1036 mmHg (SD,  $\pm 2.54631$  mmHg) and 15.4473 mmHg (SD,  $\pm 8.86315$  mmHg), respectively. For the non-operated eyes, the mean pre-operative IOP and the mean post-operative IOP were 15.1364 mmHg (SD,  $\pm 2.60870$  mmHg) and 16.2055 mmHg (SD,  $\pm 2.89670$  mmHg), respectively. The IOP in the operated eyes was significantly lower than that in the non-operated fellow eyes in the pre-operative period ( $P = 0.000$ ).

IOP elevation was found in 7%, 31%, and 49% of eyes within 1 day, 3 days, and 6 days after surgery, respectively. Multivariable linear regression was performed by taking into consideration the variables with significant effects on the development of elevated IOP using univariate linear regression. Table 2 shows the risk factors for IOP elevation. IOP elevation on the first post-operative morning was significantly associated with disease duration but not with other parameters. Table 3 shows that IOP elevation at 3 days post-operatively was significantly associated with a history of diabetes. At 6 days post-operatively, no parameter was significantly associated with IOP elevation.

## Discussion

In the current study, the mean IOP for operated eyes was significantly lower than the mean IOP for non-operated eyes before surgery. Only 4 eyes (7%) were on IOP-lowering medication on the first post-operative morning, which increased to 27 eyes (49%) within 6 days after surgery. Post-operative IOP elevation was significantly associated with disease duration on the first post-operative morning, and with a history of diabetes within 3 days after surgery.

IOP elevation is a complication following PPV to repair retinal detachment. Elyse Jabbour et al. [7] showed that the incidence of IOP elevation was higher with RRD than with tractional detachment. Another study showed an increase in IOP after PPV with indication of retinal detachment [5]. Our results showed a significant increase in IOP of 4.34 mmHg on the first post-operative morning, and increased IOP was present in 7% of eyes on the first post-operative morning. Anderson et al. [8] reported the incidence of IOP elevation to be 8.4% after vitreoretinal surgery (vitrectomy and/or scleral buckling). Our study showed that increased IOP was present 49% of eyes within 6 days after surgery. Therefore, we should monitor IOP frequently in the early postoperative period after PPV with SO injection for RRD.

This study showed that the duration of detachment was found to be associated with the risk of developing ocular hypertension in RRD on day 1 after PPV with SO injection. Yumi Hasegawa et al. [9] found that duration of detachment was significantly associated with IOP elevation within 1 day following PPV with 20% SF<sub>6</sub> gas tamponade for RRD. We found that the IOP in the operated eyes was significantly lower than that in the non-operated fellow eyes before surgery. One reason for this may be that the intraocular fluid flows out of the eye through the area of retinal detachment. The production of aqueous humor may increase to compensate for the decrease in IOP [9]. Therefore, it is possible that the IOP elevation after PPV and SO injection is caused by excess aqueous humor production when abnormal

outflow of intraocular fluid stops due to retinal reattachment in early postoperative period. SO tamponade may cause an increase in the concentrations of inflammatory cytokines. IOP should be monitored regularly in the early postoperative period, especially in those with a long history of retinal detachment. Moreover, topical prophylactic treatment may be considered in eyes with prolonged retinal detachment.

Our study showed that the presence of diabetes was associated with the risk of developing ocular hypertension in RRD at 3 days postoperatively. The results concerning the correlation between the presence of diabetes and the IOP elevation were not consistency. Our results indicated that diabetes was associated with a high risk of ocular hypertension after PPV and SO at 3 days post-operatively. On the contrary, Elyse Jabbour et al. [7] reported that diabetic patients had a lower incidence of ocular hypertension following PPV with SO injection, and the mean duration of SO tamponade was  $8.79 \pm 8.73$  months. The difference may have been caused by the different time points after PPV with SO injection. One reason for this may be that in the eyes of diabetic patients, this rise in IOP is most likely due to post-operative inflammation, which may be induced by the increase of vascular permeability in the early post-operative period after PPV and SO injection for RRD. However, during the long post-operative period, the concentrations of inflammatory cytokines are low, and the eyes of diabetic exhibit more ischemia and have a lower rate of oxygen reaching the trabecular meshwork, resulting in lower oxidative stress than that in nondiabetic eyes [7]. Thus, IOP should be monitored in the eyes with a history of diabetes.

At 6 days post-operatively, no parameter was significantly associated with IOP elevation. It is possible that the IOP elevation may be explained by the impact of topical steroid use [10]. And it requires further investigation.

There are some limitations to our study. The size of our sample is small, which may have influenced the relationship between IOP elevation and the risk factors.

## Conclusions

The current study showed an early postoperative IOP elevation after PPV and SO in RRD. Furthermore, a long duration of detachment and a history of diabetes were risk factors that were significantly associated with postoperative IOP elevation. Careful monitoring of the IOP is needed after PPV to prevent secondary glaucoma. Furthermore, topical prophylactic treatment may be considered in eyes with higher risks of IOP elevation.

## Abbreviations

PPV: pars plana vitrectomy; RRD: rhegmatogenous retinal detachment; SO: silicone oil; IOP: intraocular pressure

## Declarations

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### **Authors' contributions**

XYZ collected data, performed all statistical analysis, and wrote the manuscript. XFH analyzed the data and assisted in manuscript writing. LKX designed the study and collected data. All authors read and approved the final manuscript.

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### **Availability of data and materials**

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

### **Ethics approval and consent to participate**

This study complied with the tenets of the Declaration of Helsinki. Ethical approval for this study and informed consent were waived by the local Ethics Committee of the Eye Hospital China Academy of Chinese Medical Sciences in view of the retrospective nature of the study.

### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare that they have no competing interests.

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## Tables

Table 1

General characteristics and intraoperative characteristics of the 55 patients after PPV with SO injection

Retinal detachment (N = 55)	
Preoperative characteristics	
Age, mean $\pm$ SD (minimum-maximum), year	56.15 $\pm$ 12.34(30–84)
Sex	
Female	26
Male	29
Eye	
Right	26
Left	29
Diabetes	
Yes	7
No	48
Hypertension	
Yes	20
No	35
High myopia (More than -6 diopters)	
Yes	15
No	40
Axial length (mm)	25.06 $\pm$ 2.14(22.05–32.09)
Duration of detachment (days)	14.47 $\pm$ 15.08(2–62)
Lens status	
Phakic	45
Pseudophakic	10
Aphakic	0
Macula	
On	19
PPV pars plana vitrectomy, SO silicone oil, SD standard deviation, Phaco + IOL phacoemulsification combined with intraocular lens implantation	

	Retinal detachment (N = 55)
Off	36
Size of retinal tears (papilla diameter)	2.47 ± 2.14 (0.2–10)
Area of retinal detachment (°)	180 ± 78.32(90–360)
PPV pars plana vitrectomy, SO silicone oil, SD standard deviation, Phaco + IOL phacoemulsification combined with intraocular lens implantation	

Table 2  
Risk factors for IOP elevation on day 1 after PPV with SO injection for RRD

Factors	SE	Beta	t	P value
Duration of detachment (days)	2.274	6.706	2.949	0.005
RRD rhegmatogenous retinal detachment				

Table 3  
Risk factors for IOP elevation at 3 days after PPV with SO injection for RRD

Factors	SE	Beta	t	P value
Diabetes	2.323	6.028	2.595	0.012

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [datasets.xlsx](#)