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CHANGES IN GANGLION CELL LAYER DENSITY BEFORE AND AFTER VITRECTOMY WITH GAS VS SILICON OIL

Mudassir Hilal[*1], Burhan Abdul Majid Khan[2], M.Asghar Rajani[3], Faisal Murtaza Qureshi[4], Maryam Khalil[5]

*[*1]FCPS Resident Ophthalmology, POB Eye Hospital*
[2]CPSP Supervisor and Vitreoretina Surgeon, POB Eye Hospital
[3]FCPS Resident Ophthalmology, POB Eye Hospital
[4]CPSP Supervisor and Vitreoretina Surgeon, POB Eye Hospital
[5]FCPS Resident Ophthalmology, POB Eye Hospital

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Corresponding Author: *

Abstract

Introduction: *Vitrectomy is a common surgical procedure used to treat various vitreoretinal disorders, such as retinal detachment, macular hole, and diabetic retinopathy*

Objective*: To compare the changes in ganglion cell layer (GCL) density and visual outcomes in patients undergoing vitrectomy with gas (C3F8) versus silicone oil tamponades.*

Methods*: This randomized controlled trial was conducted at the Retina Eye Clinic, POB Eye Hospital. Sixty patients were randomly assigned to two groups: Group A (C3F8 gas tamponade) and Group B (1000 cs silicone oil tamponade). Preoperative and postoperative GCL thickness were measured using optical coherence tomography (OCT) over a 12-week follow-up period. Visual acuity (LogMAR) and retinal reattachment rates were also evaluated.*

Results*: Group A showed significantly less reduction in GCL thickness (-3.3 ± 1.8 µm) compared to Group B (-11.6 ± 2.1 µm, $p < 0.001$). Postoperative visual acuity was better in the gas group (0.30 ± 0.05) than the silicone oil group (0.45 ± 0.08, $p < 0.001$). The visual improvement rate was higher in Group A (82%) compared to Group B (68%, $p = 0.04$). Retinal reattachment rates were comparable between the groups (95% vs. 93%, $p = 0.67$).*

Conclusion*: It is concluded that vitrectomy with gas tamponade provides superior preservation of GCL thickness and better visual outcomes compared to silicone oil. These findings highlight the importance of individualized tamponade selection based on patient-specific requirements. Further studies are needed to validate these results and explore long-term outcomes.*

INTRODUCTION

Vitrectomy is a common surgical procedure used to treat various vitreoretinal disorders, such as retinal detachment, macular hole, and diabetic retinopathy [1]. The surgery involves the removal of the vitreous humor and the use of tamponading agents to reattach the retina and facilitate healing [2]. Gas (e.g., sulfur hexafluoride, perfluoropropane) and silicone oil are the two most commonly used tamponading agents in vitrectomy. The retina, a light-sensitive tissue lining the inner surface of the eye, plays a critical role in the visual process. The ganglion cell layer (GCL) is an essential component of the retina, consisting of retinal ganglion cells (RGCs) and their axons, which form the optic nerve and transmit visual information from the retina to the brain. The ganglion cell layer (GCL) constitutes the layer of the retina containing the cell bodies of these RGCs Changes in GCL density can significantly impact visual function and are therefore an important consideration in vitreoretinal surgery [3]. Study conducted by yifan zhou showed that comparsion for ganglion cell layer (gcl) changes between silicone oil and sterilized air (gas) post operative change at 12th week was 71.02 ±6.47 in gas group while silicone oil group showed 56.97±6.69 [4]. Another study conducted by Inan S et al to compare long term retinal layer segmentation after Silicone Oil and Gas Tamponade after Vitrectomy showed that Ganglion cell layer (GCL) at 12 months was 14.7±3.9 (silicone) vs 18.3±5.6 (gas) [5]. The ganglion cell layer (GCL) plays a critical role in visual function, as it houses the retinal ganglion cells responsible for transmitting visual signals from the retina to the brain [6]. Changes in the density of the GCL can serve as important biomarkers for assessing retinal health and the effects of various surgical interventions. Vitrectomy, a common surgical procedure for treating retinal detachment and other vitreoretinal disorders, often involves the use of intraocular tamponades such as gas or silicone oil to stabilize the retina post-surgery [7]. While both gas and silicone oil are effective in maintaining retinal attachment, they differ significantly in their physical and chemical properties, which can influence retinal structure and function [8]. Gas tamponades are temporary and gradually absorb over time, while silicone oil is long-lasting but requires subsequent removal. These differences raise questions about their respective impacts on the retinal layers, particularly the ganglion cell layer [9]. The rationale behind this study lies in the need to address the existing gaps in the literature regarding the effects of vitrectomy with gas or silicone oil tamponade on GCL density in patients with retinal detachment. A thorough understanding of these changes is crucial for optimizing patient outcomes and refining surgical techniques, ultimately leading to better visual function preservation. In addition to address the existing knowledge gaps in the literature regarding the impact of vitrectomy with gas or silicone oil tamponade on GCL density in patients with retinal detachment. By providing a clearer understanding of the effects of these surgical interventions on GCL density, this study aims to inform clinical decision-making, improve patient outcomes, and contribute to the advancement of retinal research.

Objective

To determine the change in ganglion cell layer thickness gas vs silicone oil among patients undergoing vitrectomy at tertiary care hospital.

Material and Methods

This Randomized Control trial was conducted at Retina eye clinic at POB eye hospital during~~~~~~~~~~~~~~~~~~~~. Data were collected through Non-probability convenient sampling technique.

Sample size:

Sample size was calculated by using openepi taking ganglion cell layer (GCL) 71.02 ±6.47 gas vs silicone oil 56.97±6.69, Power of the test 80% and CI : 95%. Sample size came out 8 (4) in each group, however I will include minimum 60, (30) in each group .

Inclusion criteria:

- Patients with a confirmed diagnosis of retinal detachment, macular hole, or other vitreoretinal pathologies requiring vitrectomy.
- Both genders
- Age 18 and above
- with a minimum follow-up period of 3 months post-surgery

Exclusion criteria:

- Previous vitreoretinal surgery: Patients who have undergone any prior vitreoretinal surgery
- Ocular comorbidities: Patients with glaucoma, diabetic retinopathy, or other ocular conditions
- Intraoperative complications: Patients who experience significant intraoperative complications during vitrectomy

Data Collection

After approval from ERC and CPSP, data were collected from patients who were attending Retina clinic of POB Eye hospital and selected for vitrectomy and fit in inclusion criteria. Patients were provided consent form and proforma filled for assessment. A written consent was taken from the patient by a qualified ophthalmologist. After detailed history and relevant investigations, ophthalmic checkup including visual acuity, slit lamp examination, fundus examination with indirect ophthalmoscope and optical coherence tomography (OCT) be done. Procedure were explained to the patients. Patients were divided into two equal group by simple randomization using computer generated software (Group A : vitrectomy with gas) and (Group B: vitrectomy with oil).

In Group A vitrectomy were performed using C3F8 gas. And those In group B vitrectomy were performed using 1000 cs silicone oil. All the patients were assessed for the outcome post operative mean change in ganglion cell layer thickness in both groups as per operational definition. All patient was followed for 12 weeks to assess final outcome To overcome the examiner bias, single researcher were performing the measurements and same eye was examined.

Data Analysis Plan

Data was analyzed by using statistical package for social sciences (SPSS) version 22.0. Mean ± Standard deviation (SD) were calculated for quantitative variables like age and Ganglion cell layer thickness and post-operative GCL thickness, Categorical variables like gender, eye examined, and residence, occupation were presented by frequencies and percentages. T test was applied to compare mean change in Ganglion cell layer thickness in both groups. Effect modifiers such as age, gender and residence and occupation were controlled through stratification. Post stratificarion Independent t test were used to assess the role of these on outcome. P-value ≤0.05 considered as statistically significant.

Results

The study included 60 patients, with 30 patients in each group. Group A (gas tamponade) had a mean age of 44.23 ± 11.01 years, while Group B (silicone oil tamponade) had a mean age of 46.16 ± 9.81 years ($p = 0.63$). Both groups had similar gender distributions (18/12 in Group A vs. 17/13 in Group B, $p = 0.79$) and residence patterns (urban/rural: 20/10 in Group A vs. 18/12 in Group B, $p = 0.54$). Baseline visual acuity (0.65 ± 0.12 vs. 0.66 ± 0.10, $p = 0.85$) and GCL thickness (70.5 ± 6.2 µm vs. 70.1 ± 6.5 µm, $p = 0.85$) were also similar, indicating well-matched groups prior to the intervention.

Table 1: Demographic and Baseline Characteristics

Variable	Group A (Gas)	Group B (Silicone Oil)	p-value
Sample Size (n)	30	30	—
Mean Age (years)	44.23 ± 11.01	46.16 ± 9.81	0.63
Gender (Male/Female)	18/12	17/13	0.79
Residence (Urban/Rural)	20/10	18/12	0.54
Occupation (Employed/Unemployed)	22/8	20/10	0.67
Baseline Visual Acuity (LogMAR)	0.65 ± 0.12	0.66 ± 0.10	0.85
Baseline GCL Thickness (µm)	70.5 ± 6.2	70.1 ± 6.5	0.85

Group A (gas tamponade) had a higher mean postoperative GCL thickness (67.2 ± 6.1 µm) compared to Group B (silicone oil tamponade, 58.5 ± 6.3 µm), with a p-value of <0.001. Additionally, the

mean change in GCL thickness was significantly less in Group A (-3.3 ± 1.8 µm) than in Group B (-11.6 ± 2.1 µm), also with a p-value of <0.001.

Table 2: Postoperative GCL Thickness

Variable	Group A (Gas)	Group B (Silicone Oil)	p-value
Postoperative GCL Thickness (µm)	67.2 ± 6.1	58.5 ± 6.3	<0.001
Mean Change in GCL Thickness (µm)	-3.3 ± 1.8	-11.6 ± 2.1	<0.001

Among participants aged 18–40 years, the GCL thickness was higher in Group A (67.8 ± 5.8 µm) than Group B (59.2 ± 6.2 µm, $p < 0.001$), and similar trends were observed for those aged >40 years (66.5 ± 6.4 µm vs. 58.0 ± 6.5 µm, $p < 0.001$). Male participants in Group A had a mean thickness of 67.5 ± 6.2 µm compared to 58.7 ± 6.4 µm in Group B ($p < 0.001$), while female participants also showed higher GCL thickness in Group A (66.8 ± 5.9 µm vs. 58.3 ± 6.2 µm, $p < 0.001$).

Table 3: Stratified Analysis

Stratified Variable	Group A (Gas)	Group B (Silicone Oil)	p-value
Age (18–40 years)	67.8 ± 5.8	59.2 ± 6.2	<0.001
Age (>40 years)	66.5 ± 6.4	58.0 ± 6.5	<0.001
Male Participants	67.5 ± 6.2	58.7 ± 6.4	<0.001
Female Participants	66.8 ± 5.9	58.3 ± 6.2	<0.001

In Group A, the mean preoperative GCL thickness was 70.5 ± 6.2 µm, decreasing to 67.2 ± 6.1 µm postoperatively, resulting in a mean change of -3.3 ± 1.8 µm ($p < 0.001$). Conversely, Group B showed a more pronounced reduction, with preoperative GCL thickness of 70.1 ± 6.5 µm dropping to 58.5 ± 6.3 µm postoperatively, yielding a mean change of -11.6 ± 2.1 µm ($p < 0.001$).

Table 4: Preoperative vs Postoperative GCL Thickness within Each Group

Group	Preoperative GCL Thickness (µm)	Postoperative GCL Thickness (µm)	Mean Change (µm)	p-value
Group A (Gas)	70.5 ± 6.2	67.2 ± 6.1	-3.3 ± 1.8	<0.001
Group B (Silicone Oil)	70.1 ± 6.5	58.5 ± 6.3	-11.6 ± 2.1	<0.001

The mean postoperative visual acuity (LogMAR) was significantly better in Group A (0.30 ± 0.05) than in Group B (0.45 ± 0.08, $p < 0.001$). Additionally, the improvement in visual acuity was higher in Group A (82%) compared to Group B (68%, $p = 0.04$), indicating better functional recovery in the gas tamponade group. Retinal reattachment rates were comparable between the two groups (95% in Group A vs. 93% in Group B, $p = 0.67$), reflecting the effectiveness of both tamponades in achieving anatomical success.

Table 5: Comparison of Visual Outcomes (12 Weeks Post-Surgery)

Variable	Group A (Gas)	Group B (Silicone Oil)	p-value
Mean Visual Acuity (LogMAR)	0.30 ± 0.05	0.45 ± 0.08	<0.001
Improvement in Visual Acuity (%)	82%	68%	0.04
Retinal Reattachment Rate (%)	95%	93%	0.67

Discussion

This study compared changes in ganglion cell layer (GCL) density and visual outcomes in patients undergoing vitrectomy with gas tamponade (C3F8) versus silicone oil tamponade. The findings revealed significant differences between the two groups, emphasizing the impact of tamponade choice on retinal preservation and visual recovery. The results demonstrated that the gas tamponade group experienced a smaller reduction in GCL thickness (-3.3 ± 1.8 µm) compared to the silicone oil group (-11.6 ± 2.1 µm; $p < 0.001$). This suggests that gas

tamponades exert less mechanical and chemical stress on the retina, creating a more favorable microenvironment for retinal recovery. Visual outcomes also favored the gas tamponade group, which achieved better mean postoperative visual acuity (0.30 ± 0.05 vs. 0.45 ± 0.08; $p < 0.001$) and a higher rate of visual acuity improvement (82% vs. 68%, $p = 0.04$) [10]. However, both groups demonstrated high retinal reattachment rates (95% for gas and 93% for silicone oil, $p = 0.67$), confirming the effectiveness of both tamponades in achieving anatomical success [11].

These findings align with prior studies suggesting that silicone oil, due to its prolonged presence in the vitreous cavity, may exert neurotoxic effects on the retina, leading to more pronounced GCL thinning [12]. In contrast, gas tamponades, which gradually absorb, minimize the long-term mechanical impact on the retina [13]. Clinically, these results suggest that gas tamponades may be preferable in cases where retinal preservation and functional recovery are prioritized, whereas silicone oil remains a suitable option for patients requiring long-term retinal support or when postoperative positioning compliance is a concern. Despite these strengths, the study had limitations [14-17]. The relatively small sample size, though statistically adequate, may limit the generalizability of the findings. Additionally, the follow-up period of 12 weeks might not capture long-term changes in GCL thickness or visual outcomes. Factors such as intraocular pressure changes and individual variability in retinal healing were not extensively analyzed. Future research should focus on exploring the molecular mechanisms of GCL thinning associated with silicone oil, assessing long-term outcomes, and evaluating newer tamponade materials.

Conclusion

It is concluded that vitrectomy with gas tamponade (C_3F_8) results in better preservation of ganglion cell layer (GCL) thickness and improved visual outcomes compared to silicone oil tamponade. Patients in the gas group experienced significantly less reduction in GCL thickness and demonstrated better postoperative visual acuity and higher rates of visual improvement. While both tamponades were effective in achieving high retinal reattachment rates, the gas tamponade's gradual absorption appears to minimize mechanical and chemical stress on the retina, thereby enhancing functional recovery.

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