Al-Azhar International Medical Journal

Volume 5 | Issue 7 Article 4

7-31-2024
Section: Ophthalmology

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How to Cite This Article

Aly, Hassan Abdel Wahab; Mostafa, Mostafa Mahmoud; Mohammed, Ehab Abdelaziz; and Elmenofy, Tarek Mohamed Ibrahim (2024) "Evaluation of Ganglion Cell Layer in Silicone Filled Eyes by Optical Coherence Tomography," *Al-Azhar International Medical Journal*: Vol. 5: Iss. 7, Article 4.
DOI: https://doi.org/10.58675/2682-339X.2522

ORIGINAL ARTICLE

Evaluation of Ganglion Cell Layer in Silicone Filled Eyes by Optical Coherence Tomography

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Abstract

Background: ***The most tolerated temporary endo tamponade material in treating complex forms of retinal detachment is still silicone oil (SiO). Because SiO is poisonous and causes irritation, removing it many months following surgery is advised.***

Aim of the work: ***To use optical coherence tomography (SD-OCT) to investigate variations in the retina layer of ganglion cells during silicone oil prevention and determine when it is best to remove it.***

Patients and methods: ***This cross-sectional and prospective observational study involves 40 patients at the Memorial Institute of Ophthalmology and Al Azhar University Hospitals who will have pars plana vitrectomy with silicone oil tamponade for primary rhegmatogenous retinal detachment.***

Results: ***The illness persisted for two days to ninety days on average ± S.D of 34.15 ± 21.44 days. Ganglion cell layer (GCL) thickness average at one week had a mean ± S.D of 81.8 ± 6.53, then decreased to 79.5 ± 6.19 77.85 ± 6.63 at one months and two months, respectively. Eventually, it dropped to 67.7 ± 6.19 at three months.***

Conclusion: ***This study suggested that (GCL) thickness average decreases over time in silicone-filled eyes, which is affected more after two months. It showed that the correlation between (GCL) thickness average at three months and age had a negative correlation.***

Keywords: Ganglion cell; Silicone filled eyes; Optical coherence tomography

1. Introduction

Successful detachment surgery can prevent several consequences, including secondary glaucoma. This particular complication is both familiar and challenging because it may cause the retinal nerve fibre layer (RNFL) to deteriorate and harm visual quality.[1,2]

Studies conducted in both clinical and experimental settings demonstrate the importance of SiO in raising the IOP in silicone oil-filled eyes. Fibroblasts lining the uveoscleral pathway and the endothelial cells in the trabecular meshwork, the animal models' iris cells revealed the existence of silicone oil 2 and 4 weeks after its insertion. Based on these research findings, SiO is observed to move from the anterior chamber through both the traditional and unconventional pathways.[3,4,5,6,7]

Knorr et al. reported that SiO vacuoles were found in the eye's retina and optic nerve four weeks after administration.[6]

In all eyes, a persistent inflammation of cellular infiltration was noted, primarily near SiO vacuoles, seen in every retina layer. Several authors have argued that removing SiO does not disrupt the inflammatory process triggered by its insertion, hence accounting for the enduring consequences of SiO consumption. The authors observed a correlation between vacuoles in the optic nerve and increased intraocular pressure (IOP), which made these eyes more susceptible cause injury to the optic nerve. As a result, the authors advise eliminating the SiO right away.[7,8]

Silicone optic neuropathy can arise due to (IOP) or silicone oil's direct harmful effects on the nerve that controls vision.[9,10]

Numerous histological and clinical investigations have confirmed SiO penetration into the ocular tissues.[11,12]

Accepted 21 July 2024.
Available online 31 July 2024

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https://doi.org/10.58675/2682-339X.2522

The implementation of (OCT) in clinical practice has allowed for the objective and quantitative study of the (RNFL) and (GCL) complex. Authors employed spectral-domain OCT (SD-OCT) to ascertain the existence of emulsified SiO particles following endo tamponade. The scientists discovered minute hyperreflective regions/globules within the retina, beneath the retina, and under the epiretinal membranes. These areas were suspected to be tiny droplets of SiO.[13,14]

Furthermore, Geber et al. It has been found that in the peripapillary retinal nerve fibre layer Over six months, the RNFL among individuals with silicone oil endo tamponade is notably thicker than that of their counterparts without surgery.[15]

This study intends to explore the differences in retinal GCL thickness during SiO tamponade using SD-OCT to identify the most appropriate timing for its removal.

2. Patients and methods

This prospective observational cross-sectional study included forty patients receiving pars plana vitrectomy with silicone oil tamponade for primary rhegmatogenous retinal detachment at Al-Azhar University Hospitals and the Memorial Institute of Ophthalmology.

All patients in this study undergo a comprehensive ophthalmological examination before and after the surgery. The check-up occurs a week, thirty days, and three months after the procedure. The examination includes tests for uncorrected visual acuity and best corrected visual acuity, measurement of intraocular pressure using a Goldman application tonometer, and a thorough examination of the fundus.

Inclusion criteria: Age more than eighteen, primary rhegmatogenous detached retina, and no prior history of retinal operations in either eye.

Exclusion criteria: Subretinal proliferative vitreoretinopathy (PVR), further forms of retinal detachment, complicated surgical procedures, other retinal abnormalities, and underlying ocular hypertension or glaucoma.

Prior to (OCT) imaging, all eyes under examination underwent pupil dilation with a 1% concentration of tropicamide. Subsequently, a micrometre assessment of (GCL) thickness was conducted using a high-definition (OCT) device that utilizes spectral domain technology. The (OCT) scans were conducted one week, one month, two months, and three months following the intra-ocular silicone injection.

Ethical approval: Prior to participating in the trial, all patients were interviewed and provided with a signed informed consent form.

Statistical analysis:

Sorting and analysis of data were performed by using Statistical Package for Social Sciences (SPSS) version 21. In this study the qualitative data were described using number and percent. Quantitative data were presented as mean and standard deviation (S.D). Parametric tests were applied for normally distributed data. Paired t-test was used to compare the dependent means of the same group. $P < 0.05$ was adopted as the level of significance.

3. Results

The current study included 40 patients (40 eyes) diagnosed with rhegmatogenous retinal detachment (RRD). These patients underwent parsplana vitrectomy, Subsequently, the progression of (GCL) was documented at intervals of one week, one month, two months, and three months.

Table 1. Age description of the study patients.

	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
AGE	46.27	11.11	20.00	63.00

The current study included 40 patients; The ages of the individuals varied between 20 and 63, with an average (mean) age of 46.27 years and a standard deviation of 11.11 years. More than half of the patients were female (55.0%) and the male patients represented 45.0%.

Table 2. Sex distribution of the study participants

GENDER	NO	%
MALE	18	45.0
FEMALE	22	55.0

Table 3. Disease duration, side eye and the cause of the study patients.

DISEASE CHARACTERISTICS	N	%
SIDE		
OD	19	47.5
OS	21	52.5
RISK FACTORS		
TRAUMA	10	25.0
HIGH MYOPE	24	60.0
DURATION (DAYS)		
MEAN ± S.D	34.15 ± 21.44	
RANGE	2.00 - 90.00	

Regarding the side of the diseased eye, OD represented 47.5% and OS represented 52.5%. As regards the risk factors, one quarter (10 patients) had history of trauma, while 60.0% of them were high myope. The disease duration in days ranged from 2 days up to 90 days with a mean ± S.D of 34.15 ± 21.44 days,

Table 4. GCL thickness average follow up among the study patients.

GCL THICKNESS AVERAGE IN MICROMETER	MEAN	STANDARD DEVIATION (S.D)	MINIMUM	MAXIMUM
ONE WEEK	81.80	6.53	67.00	95.00
ONE MONTHS	79.50	6.19	65.00	93.00
TWO MONTHS	77.85	6.63	64.00	92.00
THREE MONTHS	67.70	6.19	60.00	87.00

GCL thickness average at one week had a mean ± S.D of 81.8 ± 6.53 then decreased to 79.5 ± 6.19 & 77.85 ± 6.63 at one months and two months, respectively. Eventually, it dropped to 67.7 ± 6.19 at three months.

Table 5. GCL thickness average comparison between 1week and 1 month.

GCL THICKNESS AVERAGE IN MICROMETER	MEAN	STANDARD DEVIATION (S.D)	MINIMUM	MAXIMUM	P VALUE
1 WEEK	81.80	6.53	67.00	95.00	< 0.001*
1 MONTH	79.50	6.19	65.00	93.00	

*: statistically significant results

Table 5 shows the comparison between (GCL) thickness average at one week and one month. GCL thickness average at one week ranged from 67.0 to 95.0 with a mean ± S.D of 81.8 ± 6.53, while it had a range from 65.0 to 93.0 with a mean ± S.D of 79.5 ± 6.19 at one month. The observed difference was statistically significant (p = 0.001), as indicated in Figure 1.

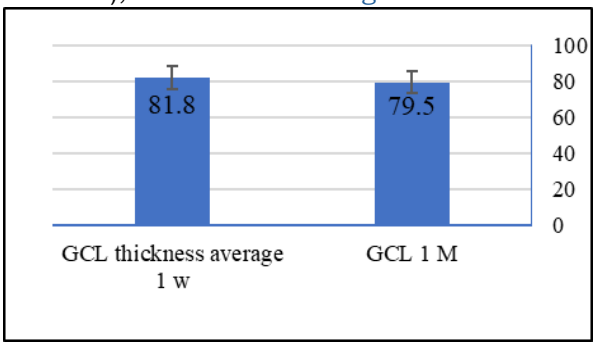

Figure 1. GCL thickness average comparison between 1week and 1 month.

Table 6. GCL thickness average comparison between 1 month and two months.

	MEAN	STANDARD DEVIATION (S.D)	MINIMUM	MAXIMUM	P VALUE
GCL 1 M	79.50	6.19	65.00	93.00	< 0.001*
GCL 2 M	77.85	6.63	64.00	92.00	

*: statistically significant results

Table 6 shows the comparison between (GCL) thickness average at one month and two months. GCL thickness average at one month ranged from 65.0 to 93.0 with a mean ± S.D of 79.5 ± 6.19, while it ranged from 64.0 to 92.0 with a mean ± S.D of 77.85 ± 6.63. The observed discrepancy was found to be statistically significant (p = 0.001), as illustrated in Figure 2.

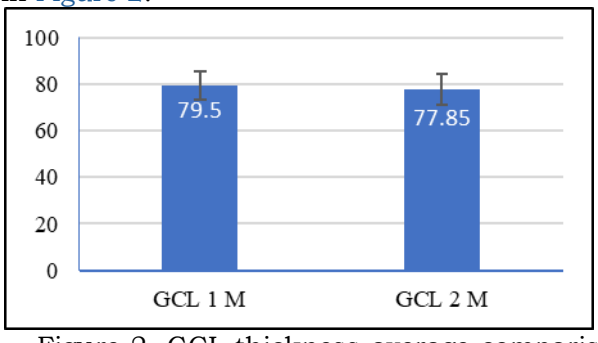

Figure 2. GCL thickness average comparison between 1 month and two months.

Table 7. GCL thickness average comparison between two month and three months.

	MEAN	STANDARD DEVIATION (S.D)	MINIMUM	MAXIMUM	P VALUE
GCL 2 M	77.85	6.63	64.00	92.00	< 0.001*
GCL 3 M	67.70	6.19	60.00	87.00	

*: statistically significant results

Table 7 shows the comparison between (GCL) thickness average at two months and three months. GCL thickness average at one month ranged from 64.0 to 92.0 with a mean ± S.D of 77.85 ± 6.63, while it ranged from 60.0 to 87.0 with a mean ± S.D of 67.70 ± 6.19. The observed discrepancy was statistically significant (p = 0.001), as evidenced by Figure 3.

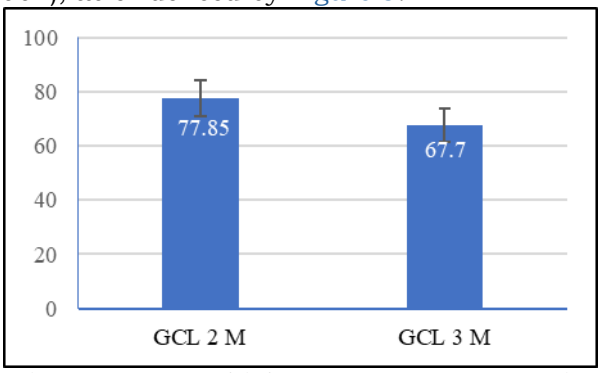

Figure 3. GCL thickness average comparison between 1 month and two months.

4. Discussion

Regarding the demographic characteristics of the patients under study, we observed that their ages varied between 20 and 63, with an average ± standard deviation of 46.27 ± 11.11 years. Most patients were female, accounting for 55.0%, while males accounted for 45.0%.

Also, our results consistent with Kheir et al.. A study investigated the effects of SO tamponade after vitrectomy during spectral domain imaging using (OCT). The study aimed to assess objective and subjective changes before, during, and after the removal of SO from the eye. The participants had a mean age of 48.1 years (25-73).[16]

The present study elucidates the characteristics of the condition. OD represented the diseased eye at 47.5% and OS at 52.5%. Regarding the risk

factors, 25% (10 patients) had previous records of trauma. However, 60.0% of them had excessive myopia. The disease duration varied from 2 to 90 days, with an average ± standard deviation of 34.15 ± 21.44 days.

Our results are consistent with Raczyńska et al. In comparison to other endo tamponade types, such as sulfur hexafluoride gas (SF6) perfluoropropane gas (C3F8), which are utilized during pars plana vitrectomy (PPV) for (RRD), the study sought to evaluate the effects of SiO on GCL-IPL. The findings revealed that between the risk variables, trauma history was present in 25% (19 patients), and excessive myopia was present in 36.8% of the patients.[17]

The median thickness of the (GCL) varied statistically significantly between the one-week and one-month time intervals, according to the current study.

According to the two studies mentioned above, Purskhvanidze et al. Compared to the thinning shown after gas tamponade, it was demonstrated that the inner retinal layer underwent significant thinning in the fovea/parafovea area after SO tamponade.[18]

Our results are consistent with Lee et al. A study examined the structural alterations in the foveal microvasculature of patients with rhegmatogenous retinal detachment (RRD) who underwent vitrectomy and (SO) tamponade. The average thickness varied in a statistically significant way, according to the study of the (GCL) using optical coherence tomography angiography (OCTA).[19]

Also, our results, consistent with Raczyńska et al., discovered a statistically significant disparity in the average thickness of the (GCL).

According to the current study, the average thickness of the (GCL) varied statistically significantly between the one-month and two-month time points.[17]

Also, our results are consistent with those of Purtskhvanidze et al. This study aimed to evaluate the thickness of retinal layers in eyes treated with (SiO) or gas endo tamponade after they developed macula-off retinal detachment using (OCT). When comparing the SiO group to the Control group, the researchers found that the SiO group's (GCL) thickness was significantly thinner.[18]

Our results are consistent with Raczyńska et al.; The researchers discovered a considerable decrease in the level of the GCL-IPL complex in the analyzed eye compared to the control eye.[17]

Also, Our results are consistent with Lee. et al., in eyes with macula-on detached retinas (RD), the study sought to evaluate and compare the effects of silicone gas and oil on the thickness of all retinal layers. The findings revealed that the reduced thickness of the ganglion cell layer (GCL) showed the strongest correlation with alterations in visual acuity among the silicone oil group.[20]

Also, Our results are consistent with Lee et al.,. They demonstrated that three months following the surgical removal of silicone oil, when compared to the unaffected eyes, the procedure's patient eyes had noticeably thinner central foveal thickness (CFT) and macular ganglion cell-inner plexiform layer (GPL).[19]

In disagreement with our result, Kheir et al., The researchers discovered that the average thickness of the (GCL) increased over time. The thickness of the GCL varied considerably during the use of (SiO) tamponade and after its removal (P = 0.03), but there was no difference in thickness between the baseline and after SO removal (P > 0.99). We added the eyes of nine patients, totalling ten eyes. After removing the SiO, the foveal contour flattening during SiO tamponade was utterly reversed. The average thickness of the cube and GCL decreased after using SO tamponade and increased after removing the SO (P = 0.01 and P = 0.02, respectively). The outer retinal thicknesses remained constant across the three-time points (P = 0.09).[16]

The current study found a negative correlation between age and the average (GCL) thickness at three months. However, this correlation was not found to be statistically significant. The average thickness of the (GCL) showed a negative connection with disease duration at one week, three months as opposed to one month. However, this relationship lacked statistical significance.

Also, according to Zhong X f et al., the considerable thinning seen is attributed to probable reasons such as an inflammatory process caused by excessive reactivity towards silicone oil or emulsified SiO. This leads to the release of apoptotic cytokines, malfunction of Muller cells and injury to the retina. [21,22,23]

4. Conclusion

This study suggested that the GCL thickness average decreases over time in silicone-filled eyes, and it is more affected after two months. It showed a negative correlation between the GCL thickness average at three months and age.

4.1.Recommendations

Increased sample size and extended research are necessary to validate the findings of our observations..

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

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