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Subfoveal Choroidal Thickness Changes Following Pars Plana Vitrectomy with Silicone Oil Endotamponade for Rhegmatogenous Retinal Detachment

Hossam El-Din Mohamed Ahmed Khalil [a], *Ahmed Taha Gouda* [b] *Tarek Ibrahim Badr* [b] *and Engy Abd El-Malak Wahba* [b]

[a] Ophthalmology department, Faculty of Medicine, Beni-Suef University, Egypt

[b] Ophthalmology department, Faculty of Medicine, Beni-Suef University, Egypt

Abstract:

Introduction: The choroid is a thin brownish membrane composed of blood vessels, melanocytes and connective tissue. It is main function is to supply the outer layer of the retina with blood and nutrients. Silicone oil (SiO) is a widely used intravitreal tamponade in the repair of retinal detachment (RD) when long-term tamponade is needed. With the advancement of spectral domain optical coherence tomography (SD-OCT), in vivo images of the choroid with sufficient contrast and resolution are now available for measuring choroid thickness (CT) and visualizing choroid microstructures. **Aim of the work**: To assess subfoveal choroidal thickness changes following pars plana vitrectomy with silicone oil endotamponade for rhegmatogenous retinal detachment 3 months after pars plana vitrectomy and 1 month after silicon removal. **Patients and methods**: In our study we will include 25 patients who underwent Pars plana vitrectomy (PPV) and Silicon oil endotamponade injection and subsequent Silicon removal for rhegmatogenous RD in our Retina clinic. we measure SFCT 3 months after PPV and silicon injection and one month after silicon removal using optical coherence tomography (SD-OCT). **Results**: mean SFCT values of the RRD operated eyes were 270.6 ± 7.3 um 3 months after PPV and 252.2 ± 11.3 um 1 month after SiO removal. When the mean values were compared, the decrease in SFCT was statistically significant (p = **<0.0001**, ANOVA). **Conclusion:** SFCT seems to decrease after the removal of the SiO which indicates that choroidal parameters should be taken into account during or after surgery for rhegmatogenous RD.

Keywords : CT: choroid thickness; RRD: rhegmatogenous retinal detachment; SiO: Silicon oil

1. Introduction:

Silicone oil (SiO) is a widely used intravitreal tamponade in the repair of retinal detachment (RD) when long-term tamponade is needed. Although its use resulted in promising anatomical and functional results, visual loss without any apparent explanation has been reported in several cases[1-2].

The etiology of this complication is due to several factors in different studies, such as lesions of ganglion cells and horizontal-bipolar cell synaptic process in the outer plexiform layer causing generalized macular dysfunction [3]**,** progressive thinning of inner retinal layers in the macular region [4] and direct infiltration of optic nerve by Silicon oil leading to optic nerve dysfunction[5].

The choroid has many functions in the eye including metabolic support to the retinal pigment epithelium (RPE) and the outer retina. It also contributes in blood supply to the prelaminar portion of the optic nerve, has melanocytes to absorb excess light penetrating the retina and RPE, and also acts as a heat dissipating mechanism of the macula. It also plays an important role in the pathogenesis of many diseases of the posterior segment of the eye[6].

Recent development of enhanced depth imaging has made choroidal examination with spectral-domain optical coherence tomography (SD-OCT) possible.

Short-term changes in human choroidal thickness have been reported, associated with the time of the day, smoking, coffee and caffeine intake[7].

In this study, we aimed to investigate any potential effect of PPV procedure and intraocular SiO endotamponade on subfoveal choroidal thickness (SFCT) in patients operated for rhegmatogenous RD.

2. Aim of the Work:

Assessment of subfoveal choroidal thickness changes following pars plana vitrectomy with silicone oil endotamponade for rhegmatogenous retinal detachment 3 months after pars plana vitrectomy and 1 month after silicon removal.

3. Patients and Methods:

In our study we will include 25 patients who underwent Pars plana vitrectomy (PPV) and Silicon oil endotamponade injection and subsequent SiO removal for rhegmatogenous RD in our Retina clinic.

Type of study, comparative study of sub-foveal choroidal thickness 3 months after silicon injection and one month after silicon removal.

Patients will be recruited from retina clinic in Faculty of Medicine Beni Suef University and Memorial Institute Of Ophthalmology in Giza.

3.1 Preoperative assessment:

- Best corrected visual acuity (BCVA) using a snellen chart
- Slit-lamp examination.

- Intraocular pressure (IOP) measured by Goldman
- applanation tonometry.
- Binocular fundoscopy.
- B-scan ultrasonography

3.2 Intraoperative criteria:

- Type of anathesia : local anathesia.
- The same vitreoretinal surgeon performed all surgeries.
- All eyes will treated with 23-gauge PPV using a non-contact wide-angle viewing system and the ZEISS LUMERA 700 operating microscope.
- All retinal tears will treated with endolaser photocoagulation, which will performed under perfluorocarbon (PFC). A 360° endolaser treatment will performed.
- Injection of Silicon oil under air. Silicon with viscosity of 1000 centistokes (cSt) will used.
- Silicon removal will performed 3–6 months after the primary RD surgery through 23-gauge pars plana sclerotomy with active drainage followed by at least three fluid–air exchanges to remove as much residual Silicon oil as possible.

3.3 Postoperative imaging plan:

- Subfoveal choroidal thickness (SFCT) measurment will taken with SD-OCT 3 months after PPV and 1 month after SiO removal.
- Choroidal thickness is defined as the distance from the outermost layer of the RPE to the inner scleral border will measured manually using the caliper tools.
- There is no complications of imaging.

Statistical Analysis:

Data were collected, revised and entered to the statistical package for social science SPSS version 23 and presented as mean, standard deviations and ranges.

The comparison between two groups with quantitative data and parametric distribution was done by using **Independent t-test** while the comparison between more than two groups was done by using **One Way Analysis of Variance (ANOVA).**

Spearman correlation coefficients were used to assess the correlation between two quantitative parameters in the same group.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

$P > 0.05$: Non significant.

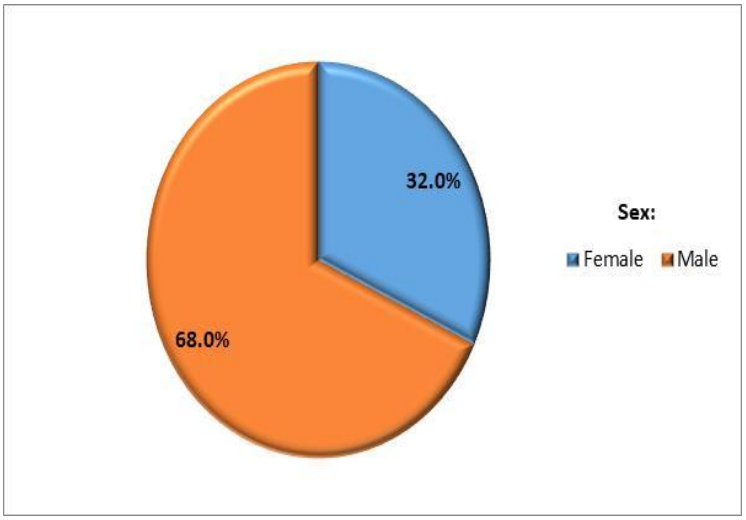
$P < 0.05$: Significant.

$P < 0.01$: Highly significant.

4. Results:

Table (1): Number of the patients and range of the age, gender.

	Mean ± SD	**Range**
Age	51.8 ± 16.7	(17-72)
	N	**%**
Gender		
Female	8	32.0%
Male	17	68.0%



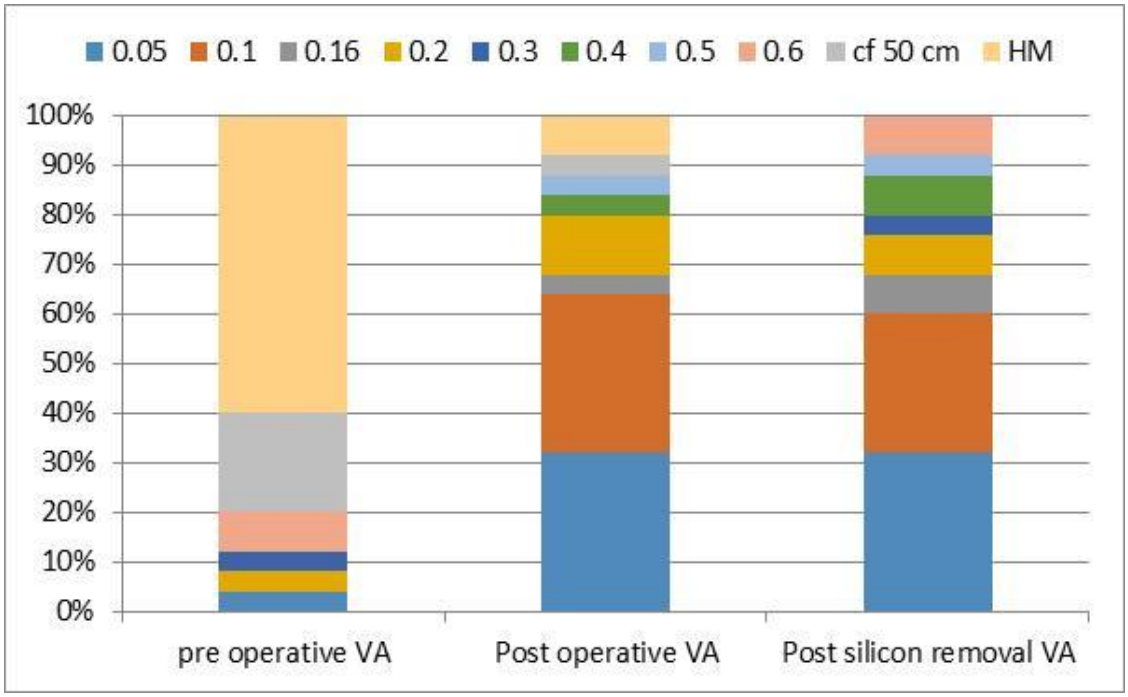
Figure(1): Gender Percentage.

In our study, we have 25 patients with wide range of age from (17-72) and gender percentage 68% males to 32% females.

Table (2): Correlation between VA pre-operative (pre PPV), VA post-operative (post PPV), VA Post silicon removal.

	Pre-operative VA		**Post-operative VA**		**Post silicon removal VA**	
	N	**%**	**N**	**%**	**N**	**%**
0.05	1	4.0%	8	32.0%	8	32.0%
0.1	0	0.0%	8	32.0%	7	28.0%
0.16	0	0.0%	1	4.0%	2	8.0%
0.2	1	4.0%	3	12.0%	2	8.0%
0.3	1	4.0%	0	0.0%	1	4.0%

0.4	0	0.0%	1	4.0%	2	8.0%
0.5	0	0.0%	1	4.0%	1	4.0%
0.6	2	8.0%	0	0.0%	2	8.0%
cf 50 cm	5	20.0%	1	4.0%	0	0.0%
HM	15	60.0%	2	8.0%	0	0.0%



	Mean ± SD	**Range**
Post-operative VA	0.13 ± 0.12	(0.05-0.5)
Post silicon removal VA	0.18 ± 0.18	(0.05-0.6)
P-value	**0.004 (S)**	

Table (3): Range of IOP in siliconized eye and after silicon removal.

	Mean ± SD	**Range**
IOP in siliconized eye	22 ± 1.8	(18-26)
IOP after silicon removal	14.4 ± 2.7	(10-20)
P-value	**0.028 (S)**	

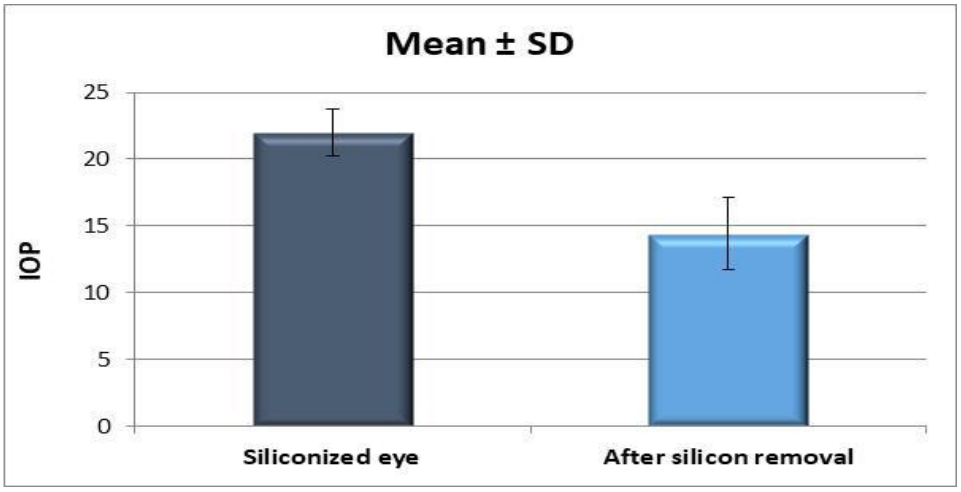


Figure (2): Relation between IOP in siliconized eye and after removal of silicon.

The previous table shows that there is statistically significant correlation found between IOP in siliconized eye and IOP after removal of silicon. P-Value = 0.028.

Table (4): Range of SFCT 3 months after silicon injection and 1 month after silicon removal.

	Mean ± SD	**Range**
SFCT 3 months after Silicon Injection	270.6 ± 7.3 um	(258-288)um
SFCT 1 month after Silicon Removal	252.2 ± 11.3 um	(240-285)um
P-value	**<0.0001 (S)**	

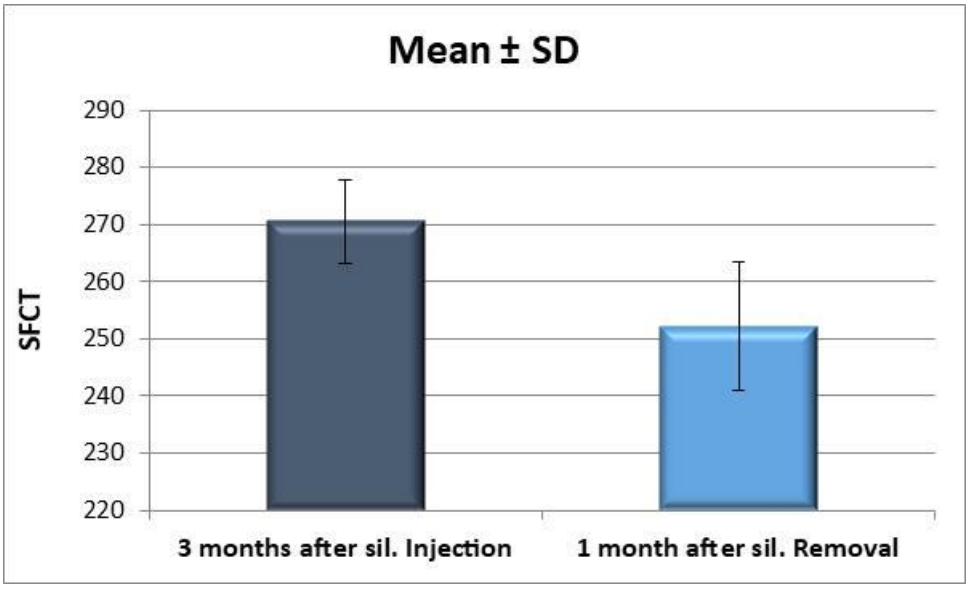


Figure (3): Relation between SFCT 3 months after silicon injection and 1 month after silicon removal.

The previous table shows that mean SFCT values of the RRD operated eyes were 270.6 ± 7.3 um 3 months after PPV and 252.2 ± 11.3 um 1 month after SiO removal. When the mean values were compared, the decrease in SFCT was statistically significant (p = **<0.0001**, ANOVA).

5. Discussion:

Rhegmatogenous retinal detachment is the most common ophthalmaic emergency threatening vision, with an incidence between 6.3 and 17.9 per 100, 000 population with significant geographical variation. A high index of suspicion for the presence of RRD as a cause of visual field loss, floaters, and photopsias. Epidemiologic studies have identified myopia and prior cataract surgery as the main risk factors [8].

The choroid is a thin brownish membrane composed of blood vessels, melanocytes and connective tissue. It extends from the optic disc to the oraserrata forming the posterior part of the uveal tract. It is thicker at the posterior pole (0.2 - 0.3 mm) than in the periphery (0.1 - 0.15 mm). The choroid has four microscopic layers; lamina suprachoroidea (lamina Fusca), stroma containing vessels, chorio-capillaries and Bruch's membrane. The choroid has racial variations being darker in pigmented races; while the choroidal vessels are easily seen in the white races [6].

Choroidal imaging can be done using different instruments. Choroidal imaging and thickness measurements have been reported with several commercially available OCT systems. In our study we use Optovue RTVue (Optovue Inc., Fremont, CA, USA) for subfoveal choroidal thikness measurement. It is measured manually perpendicularly from the outer edge of the hyperreflective retinal pigment epithelium (RPE) to the inner sclera (choroid–sclera junction)[9].

Silicone oil endotamponade has been used in pars plana vitrectomy (PPV)as a treatment in rhegmatogenous retinal detachment (RRD). Silicone oil (polydimethylsiloxane) is a linear synthetic polymer composed of repetitive Si-O units and meets all the requirements for intraocular use. Currently, the use of silicone oil as a surgical tamponade has become a standard technique in the treatment of retinal detachments. However, silicone oil emulsification appearing in variable periods from the initial surgery may lead to secondary complications [10].

A number of case series have been reported where profound central visual loss has been found in eyes after uncomplicated vitrectomy with SiO tamponade for RRD in eyes with good visual potential [1-2].

The choroidal thickness has been shown to fluctuate after scleral buckling surgery by several studies. In a study by Kimura et al., the subfoveal choroidal thickness changed temporarily following segmental scleral buckling surgery[11].

Similar results are obtained in another study involving 11 patients who had been operated with scleral buckle by Miura et al[12]. This was attributed to reversible subclinical microcirculatory dysfunction of the choroid in both studies. Moreover,

inflammation and transient IOP decrease during the surgery is said to contribute to changes in SFCT. Nevertheless, the effect of intraocular surgery on choroidal morphology seeks further research.

Another study was aimed to examine the impact of silicone oil after pars plana vitrectomy on the ganglion cell complex, inne plexiform layer thikness. The ganglion cell is a neuron type located in the retina and takes part in transmitting visual information from the retina to the brain. SD-OCT analysis detected a significant reduction of average GCL-IPL thickness and reduction of GCL-IPL parameter in almost all examined sectors in the group with silicone oil endotamponade[13].

In our study, we evaluated changes in the SFCT 3 months after PPV with SiO injection and 1 month after removal of the SiO.

Comparing the SFCT values obtained, we have found that the mean SFCT tends to show a significantly decrease ($p = <0.0001$, ANOVA).

This result may have been obtained due to several reasons. First of all, the difference may be the result of a possible actual decrease in SFCT due to the presence of intraocular SiO, due to mechanical or pressure -related effects. As we found mean IOP in siliconized eye 22 ± 1.8 mmHg range from (18-26)mmHg.

Secondly, the decrease may also be due to the effect of surgical procedure of SiO removal, instead of the effect of intraocular SiO. The effect of posterior segment surgical intervention on SFCT has not been studied in detail.

Our study has several limitations, including a small sample size, short-term follow-up. Moreover, reproducibility of the choroidal thickness measurement in SiO-filled eyes using OCT is debatable. One other limitation of our study is the lack of preoperative data. These data could give us information on the effect of RRD itself on changes in choroidal thickness in the foveal area. However, it is difficult to perform good-quality EDI-OCT in eyes where the macula was detached before the surgery. A control group with rhegmatogenous RD treated with PPV and an endotamponade other than SiO may have given valuable information in comprehending the results of our study.

6. Conclusion:

In conclusion, intraocular SiO used in pars plana vitrectomy as endotemponade in reghmatogeous retinal detachment cases seems to affect the SFCT measured by OCT OPTUVUE. SFCT was measured 3 months after PPV with silicon injection and 1 month after silicon removal. SFCT decreases after the removal of the SiO which may be due to the presence of intraocular SiO leading to mechanical or pressure-related effects or may be the surgical procedure of the silicon removal itself.

It might be prudent and necessary to integrate choroidal thickness measurements in

management of patients with RD operated with PPV, SiO injection and removal. Further studies are needed to evaluate the accuracy and reliability of choroidal thickness measurements in the presence of intraocular SiO.

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