

Effect of Silicon Oil Tamponade and Its Removal on Central Macular Thickness in Cases of Rhegmatogenous Retinal Detachment Using Swept Source OCT

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ABSTRACT

Purpose: To evaluate the effect of silicone oil (SO) tamponade and its removal on central macular thickness (CMT) and average macular thickness (AMT).

Study Design: Quasi experimental study.

Place & Duration of Study: Jinnah Postgraduate Medical Centre, Karachi, from June 2021 to April 2022.

Methods: A total of 27 patients with 27 eyes with rhegmatogenous retinal detachment were included. Pars Plana Vitrectomy (PPV) with SO tamponade was performed. Removal of silicon oil (ROSO) was performed after six months. Optical Coherence Tomography (OCT) was done before PPV, one month after PPV and one month after ROSO. The Central macular thickness (CMT) and Average macular thickness (AMT) were measured and compared between operated and control eyes.

Results: The mean CMT and AMT before surgery was $230 \pm 60.5 \mu\text{m}$ and $253.3 \pm 40.3 \mu\text{m}$ respectively. The mean CMT one month after PPV with SO was $281 \pm 62.8 \mu\text{m}$ and $232 \pm 62.2 \mu\text{m}$ in the operated eyes and control eyes ($p = 0.053$). Mean AMT one month after PPV with SO was $294 \pm 98.7 \mu\text{m}$ and $253 \pm 37.0 \mu\text{m}$ in operated and control eyes ($p = 0.182$). Mean CMT one month after SO removal was $222 \pm 81.5 \mu\text{m}$ in operated eyes and $230 \pm 59.2 \mu\text{m}$ in control eyes ($p = 0.056$). Mean AMT one month after SO removal was $263 \pm 45.0 \mu\text{m}$ in operated eyes and $254 \pm 21.4 \mu\text{m}$ in the control eyes ($p = 0.087$).

Conclusion: There was no statistically significant difference in the CMT and AMT before and after silicone oil tamponade and its removal, in patients with Rhegmatogenous Retinal Detachment.

Key Words: Retinal detachment, Pars plana vitrectomy, silicone oil, internal tamponade.

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INTRODUCTION

Silicone oil is a widely used intravitreal tamponade in complex vitreoretinal surgeries for more than 30 years. Cibis was the first who described the use of silicone oil in retinal detachment surgery in 1962.¹ To improve prognosis of complex retinal detachment secondary to giant retinal tears, proliferative vitreoretinopathy, proliferative diabetic retinopathy, vitreoretinal surgery with injection of silicone oil is recommended as a standard technique. Eyes treated with silicon oil for

retinal detachment are more likely to be reattached successfully with fewer postoperative complications compared to sulphur hexafluoride gas (SF₆) used as an intraocular tamponade. However, removal of silicon oil is recommended to avoid potential for long-term complications including cataract, glaucoma, band keratopathy, and optic neuropathy.² Removal of silicon oil (ROSO) is usually recommended as soon as a stable retinal situation is achieved but due to ROSO hypotony, cystoid macular edema (CME), development of epiretinal membranes (ERM), optic neuropathy and re-detachment can occur. Christensen and IaCour noted thinning of inner retinal layers in the SO operated eyes compared with the gas-operated eyes by using spectral domain optical coherence tomography,³ which was also noted by Caramoy et al.⁴ Since local data is scarce on OCT findings with and after removal of silicon oil, this study was designed to evaluate the effect of SO tamponade and its removal on central macular thickness (CMT).

METHODS

It was a Quasi experimental study conducted at Jinnah Postgraduate Medical Centre, Karachi, from June 2021 to April 2022. The study was approved by the ethical review board and sample was collected through Convenience sampling method. Twenty seven patients were included in which 27 eyes with rhegmatogenous retinal detachment (RRD) were operated by pars plana vitrectomy with silicon oil tamponade (PPV with SO). Informed consent was taken from all the patients. All surgeries were performed by the same surgeon to remove surgeon bias. The inclusion criteria was all patients between the ages of 15 and 70 years, either gender and who had rhegmatogenous retinal detachment with macula off. The exclusion criteria

consisted of patients younger than 15 and older than 70 years of age, patients with diabetes mellitus, glaucoma (pre-operative or developed after vitreoretinal surgery), any co-morbidity involving posterior segment (e.g. trauma, macular degeneration, uveitis, diabetic retinopathy and vascular occlusion), patients who developed epiretinal membrane after surgery, patients who developed redetachment of retina after surgery, and unwilling patients. The fellow eyes of the same 27 patients were taken as control. OCT of the patients was done one week before surgery and one month after surgery to assess central macular thickness (CMT) and average macular thickness (AMT). Six months after the first surgery, a second surgery of ROSO was done in all 27 eyes. After one month of removal of silicon oil, a third OCT was done to assess CMT and average macular thickness of the operated eye and of control eye. CMT and AMT of the operated eyes were compared with the control eyes.

Statistical software SPSS Version 19 was used for data feeding and analysis. Mean \pm standard deviation was calculated for quantitative continuous variables (central macular thickness and average macular thickness). Student t-test was used for comparison of quantitative/continuous variables of surgical and control eyes before and after ROSO. In all statistical analysis, p-value $<$ 0.05 was considered significant.

RESULTS

A total of 27 patients were included with 27 eyes with RRD requiring PPV with SO and 27 healthy eyes (fellow eyes of the same patients as controls). The results showed that the CMT and AMT in the operated and control eyes before and after ROSO was not statistically significant (Table 1).

Table 1: Comparison of Central and Average Macular Thickness between Surgical and Control eyes.

		Surgical Eyes (n = 27)	Control Eyes (n = 27)	p-value
		Mean \pm SD (μ m)	Mean \pm SD (μ m)	
Central Macular Thickness	Before surgery	230 \pm 60.5	232 \pm 62.2	0.134
	After Silicone Oil	281 \pm 62.8	232 \pm 62.2	0.053
	Post-ROSO	222 \pm 81.5	230 \pm 59.2	0.056
Average Macular Thickness	Before surgery	253 \pm 40.3	253 \pm 37.0	0.062
	Silicone Oil Group	294 \pm 98.7	253 \pm 37.0	0.182
	Post-ROSO	263 \pm 45.0	254 \pm 21.4	0.087

DISCUSSION

Pars Plana Vitrectomy (PPV) is the backbone of

surgical retina and is performed quite commonly all over the world. One of the commonest reasons of

performing PPV is retinal detachment. In this study, we tried to ascertain the effect of silicone oil tamponade on CMT after its removal in cases of Rhegmatogenous Retinal Detachment.

As there is high variation between CMT values between different ages, gender and ethnicities, we compared CMT values between the operated and healthy eyes of the same individual.⁵ In comparing the eyes from the same person, the CMT values are more uniform. The results showed that there were no differences in CMT after the removal of silicone oil (p -value > 0.05). There are studies, which show contrasting results. One such example is the study by Christensen et al,³ which included 16 subjects who had significant thinning of the inner retinal layers after ROSO leading to a decrease in CMT, as compared to healthy fellow eye of the same patient. Bae et al also recorded changes in the macular architecture following silicone oil tamponade in 46 subjects.⁶ The changes in retinal architecture varied from epiretinal membrane (26.1%) to cystoid macular edema (19.6%), along with a decrease in the central macular thickness. These changes reverted back after silicone oil removal, which reiterates our findings.

Similar findings were seen in the recent study by Rabina et al, which included findings from 41 patients showing a temporary decrease in the retinal thickness, especially in the internal retinal layers, which recovered and reached the thickness levels of the healthy fellow eye following silicone oil removal.⁷ Another study included 10 eyes, showing flattening of fovea after silicone oil tamponade.⁸ The phenomenon reversed and the fovea assumed its previous pre-operative thickness after removal of silicone oil.

An interesting study by Zhou et al, involving 39 eyes concluded that the change in retinal thickness following silicone oil tamponade was layer specific, further reporting that the inner nuclear layer and the nerve fiber layer displayed significant decrease in their thickness, whereas the outer nuclear layer, outer plexiform layer and retinal pigment epithelium depicted a significant increase in their thickness.⁹ The uniqueness of this study lies in the fact that each layer of the retina behaves differently to the effects exerted by silicone oil tamponade.

However, another study that is worth mentioning showed stark differences to our research, showing retinal thinning in all 9 subjects participating in the study following silicone oil tamponade in eyes with RRD.¹⁰ A retrospective study conducted by Zhou et al

included 21 patients out of which, 7 patients had silicone oil tamponade whereas the other 14 patients had sterile air tamponade.¹¹ All patients of the silicone oil group displayed a decrease in the various layers of the retina throughout the post-operative period till the 12th week, whereas the sterile air group initially experienced a decrease but later on an increase in the retinal thickness.

Here we would also like to include another retrospective study, which included 23 patients with silicone oil tamponade, and reported a decrease in the retinal thickness.¹² This study also included 20 patients in the silicone oil removal group which consequently showed no change in the inner retinal thickness, a finding which is echoed in our study as well. Another study based on 60 silicone oil filled eyes, reported foveal thinning in 30% of the patients after silicone oil tamponade. Surprisingly, this thinning phenomenon was not restricted to the retina alone, but also affected choroid.¹³ A study by Odrobina et al which included 18 eyes showed a sizeable decrease in choroidal thickness three months after silicone oil tamponade, which further decreased when measured six months post operatively.¹⁴ Mean sub-foveal choroidal thickness was significantly reduced following silicone oil tamponade and the choroidal thickness further decreased after silicone oil removal.¹⁵ Similar results were generated in another study by Karimi et al which showed not just a decrease in choroidal thickness after silicone oil tamponade, but also a failure of the thinned out choroid to attain its preoperative thickness.¹⁶ Interestingly, the degree of decrease in choroidal thickness was directly proportional to the duration of silicon oil tamponade. Lee et al supported these findings with his study which depicted a decrease in the vascular density of the retina following silicone oil tamponade.¹⁷ This might be one of the reasons of the decrease in retinal thickness following silicone oil tamponade.

On the contrary, there have been some recent studies, which showed an increase, rather than a decrease in the retinal layer thickness following silicone oil tamponade. Jurišić et al included 47 eyes and showed an increase in the retinal nerve fiber layer thickness after silicone oil tamponade, which interestingly, persisted even after its removal.¹⁸ Er et al on the other hand had very interesting sets of findings. He reported that the CMT after silicone oil tamponade depended on how long the oil was in the eye.¹⁹ In his study of 60 patients, he concluded that eyes that

retained silicone oil for durations less than 3 months had no discernable increase in CMT after silicone oil tamponade and even after its removal, however, in eyes with more than 3 months of silicone oil retention showed an increase, rather than a decrease in the CMT.

Multiple explanations have been suggested as the cause of this retinal thinning. One such idea which draws support from Purtskhvanidze et al is that the mechanical force acting on the retina due to the silicone oil causes the retina to become thinned out.²⁰ A second explanation, presented by Miller et al,²¹ suggests that the silicone oil emulsifies over time and may lead to a breach in the internal limiting membrane, which then would cause the silicon oil to enter the intra retinal space and damage the retina from within, thus leading to a thinned out retina. And lastly, it is also postulated that, by changing the inner environment of the eye from a hydrophilic one, due to the vitreous, to a hydrophobic one, due to the silicone oil, causes the water to drain out from the inner retinal layers, causing dehydration of the retina, ultimately leading to a decrease in the retinal thickness. However, the differences in the results reported by all these various studies show that the retina is a very diverse structure and that each layer behaves differently to the stress of silicone oil tamponade. A lot of work still needs to be done to further evaluate the cause of all these variations in the retinal thickness, preferably by keeping all other variables as much similar as humanly possible.

CONCLUSION

We found no significant difference in the CMT and AMT before and after silicone oil tamponade and its removal, in patients with Rhegmatogenous Retinal Detachment.

Ethical Approval

The study was approved by the Institutional review board/Ethical review board (F.2-81/2021-GENL/61341/JPMC).

Conflict of Interest: Authors declared no conflict of interest.

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Authors' Designation and Contribution

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