Heavy Silicone Oil for Rhegmatogenous Retinal Detachment with Inferior Breaks: Long-term Evaluation

Fatih Horozoglu (✉ fhoroz@yahoo.com)

Erciyes University School of Medicine

Hidayet Sener

Cukurca State Hospital

Osman Ahmet Polat

Erciyes University School of Medicine

Ozkan Sever

Silivri Kolan Hospital

Busra Potoglu

Namık Kemal University School of Medicine

Erkan Celik

Sakarya University School of Medicine

Elif Betul Turkoglu

Akdeniz University School of Medicine

Cem Evereklioglu

Erciyes University School of Medicine

Research Article

Keywords: Heavy-silicone oil, Silicone oil, Retinal detachment, Inferior retinal breaks

Posted Date: February 28th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1385194/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Purpose: To evaluate macular status with optical coherence tomography (OCT) in eyes that underwent pars plana vitrectomy (PPV) and heavy-silicone oil endotamponade for retinal detachment (RD) with inferior breaks.

Methods: This study included 20 eyes of 20 patients with a history of retinal detachment surgery for inferior breaks. Oxane HD was used as an intraocular tamponade for all surgeries. Anatomic reattachment, macular status with OCT imaging and any complications in the long-term were evaluated.

Results: Mean follow-up time was 19.5 ± 10.5 months (range, 10-59) after removing heavy-silicone oil or epiretinal membrane (ERM) surgery that was performed in some eyes after heavy-silicone oil removal. Primary reattachment was achieved in 90% of eyes and the success rate was 100% with further interventions. Postoperative complications included heavy-silicone oil emulsification, intraocular pressure elevation and epiretinal membrane formation.

Conclusion: Eyes treated with PPV and heavy-silicone oil injection for RD with inferior break(s) have a good ellipsoid zone (EZ) continuity in the long-term. ERM formation and removal do not affect EZ.

Introduction

Management of rhegmatogenous retinal detachment (RRD) with pars plana vitrectomy (PPV) has evolved in the past decade with the invention of smaller transconjunctival incisions and increased vitreous cut rates ¹. Despite these advances, RRD with inferior breaks especially with proliferative vitreoretinopathy (PVR) is still challenging because of difficulty in tamponading the inferior retina. Intravitreal gas may be used as a tamponade for inferior breaks. However, it is difficult to maintain postoperative positioning. Heavy-silicone oil (HSO) tamponade is another choice in treating inferior breaks without postoperative positioning as it has a specific gravity heavier than water. Oxane HD is a HSO that is reported to be effective in treating inferior RRDs. Many unfavorable postoperative complications have been reported to be associated with Oxane HD, such as cataracts, emulsification of HSO, ocular hypertension, retinal detachment and PVR, severe intraocular inflammation or uveitis, retro-oil epiretinal membranes (ERM), intraretinal or subretinal fibrosis, etc. ². Additionally, unexplained visual loss following the removal of HSO has been reported ³. We aimed to evaluate the macular status of patients that received PPV and HSO tamponade for RRD with inferior breaks using optical coherence tomography (OCT) in the long term.

Methods

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Namık Kemal University Local Ethics Committee (No: 2017/81/08/05) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Twenty eyes of 20 patients who were treated with PPV and HSO (Oxane-HD, Bausch-Lomb, USA) endotamponade for RRD with inferior break(s) were evaluated from August 2011 to December 2020. We evaluated all patients who had an OCT (Cirrus HD-OCT, Carl Zeiss Ophthalmic System Inc, USA) examination after the removal of HSO. Informed consent was signed by all patients before the operation. The study protocol was approved by the local ethics committee and adhered to the tenets of the Declaration of Helsinki.

Patients with RRD and inferior break(s) and a PVR level of B or more as graded using the Retina Society Classification ⁴ were included in the study. Eyes that met the following criteria were excluded: (1) eyes with uveitis or any inflammatory disease; (2) eyes with retinal vascular disease; (3) eyes with penetrating trauma; (4) eyes that had a previous PPV with silicone oil injection.

Best-corrected visual acuity on Snellen chart, slit-lamp examinations of the anterior and posterior segments with both non-contact and contact lenses and IOP measurement were performed. All patients had OCT evaluation at the last visit by an experienced technician. High Definition (HD) 5 Line Raster spaced at 0.25 mm was centered on the fovea with 6-mm parallel lines, 1024 A-scans/B-scans and an average of 4 B-scans per image. Three consecutive measurements were taken at the fovea. The average of three measurements was used for analysis. Any error in segmentation was corrected by a retina specialist (F.H.).

All surgeries were performed under subtenon's anesthesia by the same experienced surgeon (F.H.). All patients had 23/25-gauge transconjunctival sutureless vitrectomy. The standard surgical procedure was core vitrectomy, removing epiretinal or subretinal membranes if there was proliferation, retinotomy if needed, perfluorocarbon liquid and/or fluid-air exchange and injection of HSO. HSO was removed using an 18-gauge cannula with another PPV operation in all eyes under subtenon's anesthesia. Four eyes received the third operation for ERM surgery while 5 eyes received ERM surgery simultaneously with silicone oil removal. ERM surgeries were performed using Brilliant blue (Meran ILM dye, Turkey) and the internal limiting membrane (ILM) was removed from all eyes. In one eye, F4H5 Washout (Fluoron GmbH, Germany) was used to remove emulsified silicone oil droplets after ERM surgery.

Statistical analysis was performed using SPSS version 22 (IBM, USA). Shapiro-Wilk normality test and descriptive statistics were performed on the data set. Since the data were normally distributed, one-sample t-test, dependent samples t-test, independent samples t-test, regression analysis and Pearson correlation analysis were performed as indicated. Data that were not normally distributed were normalized as 1/data.

Results

Twenty eyes (13 right, 7 left) of 20 patients (19 men, 1 woman) with retinal detachment were included in this study. The average age was 60.4 ± 11.2 years (range, 37–83 years). The macula was detached in 8 eyes and was attached in 12 eyes. All 20 eyes had RRD with inferior breaks. None of the patients had high myopia. Eight eyes were phakic and 12 eyes were pseudophakic. The eight phakic eyes had cataract surgery before PPV.

The average post-silicone oil removal follow-up time was 19.5 ± 10.5 months (range, 10–59 months). The duration of HSO endotamponade was 15.3 ± 11.0 months (range, 6–48 months).

Retinal reattachment was achieved in 18 eyes (90%) with a first operation. Recurrent detachment occurred after silicone oil removal in 2 eyes and retinal reattachment was achieved in these 2 eyes after second operations. The macular OCT data were followed up and evaluated postoperatively. The average central foveal thickness was $191.7 \pm 57.5 \mu\text{m}$ (range, 100–274 μm). No statistically significant difference ($p = 0.065$) was found in the comparison between the average foveal center thickness in our study and the reference average foveal center thickness⁵ in the literature. The postoperative OCT image of a case with off-macular detachment is presented in Fig. 1.

Epiretinal membrane occurred in 10 eyes (50%). In 5 eyes with ERM, both silicone oil removal and ERM surgery were performed in the same session. ERM surgery was performed in 3 eyes with ERM in the first 3 months after silicone removal and in 1 eye with ERM between the 3rd and 6th months after silicone oil removal. ERM surgery was not performed in one eye with ERM. When the foveal center thicknesses of the patients who had and did not have ERM surgery were evaluated, it was observed that the average foveal center thicknesses were $162.8 \pm 50.5 \mu\text{m}$ and $225.5 \pm 48.4 \mu\text{m}$, respectively. When the correlation between ERM surgery and foveal thickness was evaluated, a statistically significant negative moderate correlation was found ($p = 0.044$, $r = -0.565$). According to simple linear regression analysis, performing ERM surgery in foveal thinning explained 31.9% of the variance ($R^2 = 0.319$, $\beta = -62.6$, 95%CI [-123.4, -1.8], $p = 0.044$). Eyes with emulsified silicone and eyes with non-emulsified silicone were found to be statistically insignificant when high intraocular pressure (IOP) and ERM were compared ($p = 0.463$, $p = 0.179$, respectively).

When preoperative (1.26 ± 0.83) and final (0.73 ± 0.51) visual acuities were compared, it was found that there was a statistically significant increase in final visual acuity ($p = 0.009$). When the preoperative and postoperative visual acuities of patients with macular detachment were compared, a statistically significant improvement was observed in visual acuity ($p = 0.018$), while there was no statistically significant increase in visual acuity in the eyes that had ERM surgery ($p = 0.263$).

Increased IOP ($> 21\text{mmHg}$) was observed in 11 eyes, which was controlled by medical treatment. Moderate aqueous inflammation was observed in one eye but fibrinous exudation and synechia were not observed. Finally, emulsification of HSO was observed in 13 eyes. No other postoperative complications were observed in the patients. The complication rates of the case series are presented in Table 1. Clinical characteristics of the patients are presented in Table 2.

According to the binary logistic regression analysis performed, no correlation was found between the time of presence of silicone in the eye and its emulsification ($p = 0.396$). According to the simple linear regression analysis performed, no correlation was found between the time of presence of silicone in the eye and the thickness of the center of the fovea ($p = 0.715$).

Discussion

Internal tamponade use is a challenging situation in eyes with inferior RRD. Prone positioning should be given after the use of silicone oil as well as intraocular gas to tamponade the inferior retina in order to avoid an unsupported retinal area by upright positioning. However, tamponade of the lower retina may not be effective and sufficient with standard silicone oil. Many studies have found that HSO is effective and safe in the treatment of inferior retinal detachment^{6,7}. However, in many studies, HSO was left in the eye as an endotamponade for 3–6 months^{6,8,9}. There are studies evaluating long-term effects, but cases with additional interventions were evaluated in these studies^{10,11}. In our study, we used HSO as the primary endotamponade in cases of RRD with inferior breaks and evaluated the long-term results.

In the present study, we describe the long-term effects of HSO and found that long-term HSO use did not have a negative effect on postoperative visual acuity. Fifteen eyes (75%) showed improvement in visual acuity. 16 eyes (80%) showed better or equal to 20/200 visual acuity after surgery. There was also improvement in visual outcomes in patients with macular detachment. Our visual results are comparable and acceptable to other studies^{10,11}.

In our study, we found that long-term HSO use did not affect central foveal thickness. Hostovsky et al., in their study with OCT in cases using HSO, observed that HSO causes temporary, reversible retinal thinning. In this study, HSO remained in the eye for up to 6 months and retinal thinning was attributed to the mechanical effect of HSO. It is reported that short-term use can prevent long-term changes in the fovea¹². In addition, it has been reported that silicone oil increases macular thickness in diabetic patients, while it causes retinal thinning in non-diabetic patients, and it has been reported that these structural changes may regress after silicone removal¹³. Disorganization of the outer plexiform layer, photoreceptors and RPE has been reported due to both mechanical stress and toxic effects of silicone oils^{14–16}. However, we observed that EZ continuity was well preserved in the long term.

In the literature, it is observed that the most common complication developing after HSO is cataracts^{2,17}. However, in our series, 40% of the cases were phakic and cataract surgery was performed during primary PPV. The most common complication in our series was the emulsification of HSO. The emulsification rate of HSO was 65% in our study, higher than that previously reported^{2,9,10,18–20}. Although there was no relationship between the presence time of silicone in the eye and emulsification in the regression analysis, it is known that the main factor affecting the tendency to emulsify is the time elapsed until the removal of these tamponades²¹. The higher rate of emulsification may have developed compared to the literature due to the long-term presence of silicone oil in the eye. Due to emulsified silicone oil droplets in one patient, the eye was cleaned using a perfluorobutylpentane (F4H5) solvent-assisted silicon oil removal technique²².

The second most common complication is elevated IOP. In our series, the rate of elevated IOP was higher than in the literature^{2,10,11,17}. In our study, eyes with emulsified silicone oil and eyes with non-emulsified silicone oil were similar in terms of elevated IOP and ERM. However, emulsified silicone oil has been reported to give predisposition to elevated IOP and ERM formation^{20,23}. Another reason could be overfilling. The elevated IOP in our series was controlled with

medical therapy and did not require surgery. ERM development was higher compared to the literature^{10,11,17}. An inflammatory reaction due to the use of silicone oil or caused by emulsified silicone, or accumulation of preretinal liquid with high inflammatory agents trapped between retina and HSO may be the precursor of this condition²⁴. In addition, it is known that with the use of HSO, the preretinal liquid, which is concentrated in inflammatory agents, is pushed upwards in the horizontal axis, the ERM is concentrated above and the posterior pole is protected²⁵. The higher rate of ERM may have developed compared to the literature due to the long-term presence of silicone oil in the eye.

The advantage of this study is that it reflects the experience of a single surgeon and a single HSO endotamponade. The limitations of the study are the retrospective design of the study and the small number of patients. Despite these limitations, our study is the first to give results on long-term HSO usage, as well as EZ continuity, according to our knowledge.

In conclusion, our present results revealed that long-term use of HSO resulted in good anatomical reattachment and satisfactory functional results. In addition, eyes treated with PPV and HSO injection for RRD with inferior breaks have good EZ continuity and foveal thickness in the long-term. However, it has been shown that long-term use of HSO increases the rate of emulsification, increased IOP and ERM. Despite the high complication rate, it is possible to preserve HSO in the eye for the long term. Prospective studies with larger series are needed to further characterize the efficacy and safety of HSO.

Declarations

Author Contribution Statement

FH, HS and OAP have made substantial contributions to the conception and design, OS, BP, EC and EBT have made substantial contributions to the acquisition, analysis, CE has made substantial contributions to the interpretation of data, FH, HS, OAP and CE have drafted the work and substantively revised it. All authors reviewed the manuscript and have approved the submitted version.

Funding

No funding was received for this research

Conflict of Interest

The authors declare no competing interests.

Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Tabandeh, H., London, N. J., Boyer, D. S. & Flynn Jr, H. W. Outcomes of small-gauge vitreoretinal surgery without scleral-depressed shaving of the vitreous base in the era of wide-angle viewing systems. *Br J Ophthalmol***103**, 1765-1768 (2019).
2. Duan, A., She, H. & Qi, Y. Complications after heavy silicone oil tamponade in complicated retinal detachment. *Retina* **31**, 547-552 (2011).
3. Lee, J., Sawant, R., Jonas, A. & Lochhead, J. The incidence of silicone oil-related visual loss following the removal of heavy silicone oil. *Eye* **33**, 1969-1970 (2019).
4. Hilton, G.*et al.* The classification of retinal detachment with proliferative vitreoretinopathy. *Ophthalmology* **90**, 121-125 (1983).
5. Chan, A., Duker, J. S., Ko, T. H., Fujimoto, J. G. & Schuman, J. S. Normal macular thickness measurements in healthy eyes using Stratus optical coherence tomography. *Arch Ophthalmol***124**, 193-198 (2006).
6. Herbrig, E., Sandner, D. & Engelmann, K. Anatomical and Functional Results of Endotamponade with Heavy Silicone Oil–Densiron® 68–in Complicated Retinal Detachment. *OphthalmicRes* **39**, 198-206 (2007).
7. Boscia, F.*et al.* Oxane HD vs silicone oil and scleral buckle in retinal detachment with proliferative vitreoretinopathy and inferior retinal breaks. *Graefes Arch Clin Exp Ophthalmol* **246**, 943-948 (2008).
8. Hussain, R. N. & Banerjee, S. Densiron® 68 as an intraocular tamponade for complex inferior retinal detachments. *Clin Ophthalmol* **5**, 603 (2011).
9. Sandner, D. & Engelmann, K. First experiences with high-density silicone oil (Densiron) as an intraocular tamponade in complex retinal detachment. *Graefes Arch Clin Exp Ophthalmol***244**, 609-619 (2006).
10. Prazeres, J.*et al.* Heavy silicone oil as a long-term endotamponade agent for complicated retinal detachments. *Biomed Res Int***2014** (2014).
11. Berker, N.*et al.* Long-term outcomes of heavy silicone oil tamponade for complicated retinal detachment. *Eur J Ophthalmol***17**, 797-803 (2007).
12. Hostovsky, A., Mandelcorn, M. S. & Mandelcorn, E. D. Transient Macular Thinning during the Use of Heavy Silicone Oil, Densiron 68. *Curr Eye Res* **46**, 350-354 (2021).
13. Lo, D. M., Flaxel, C. J. & Fawzi, A. A. Macular effects of silicone oil tamponade: optical coherence tomography findings during and after silicone oil removal. *Curr Eye Res***42**, 98-103 (2017).

14. Doi, M. & Refojo, M. F. Histopathology of rabbit eyes with silicone-fluorosilicone copolymer oil as six months internal retinal tamponade. *Exp Eye Res* **61**, 469-478 (1995).
15. Gabel, V.-P., Kampik, A. & Burkhardt, J. Analysis of intraocularly applied silicone oils of various origins. *Graefes Arch Clin Exp Ophthalmol* **225**, 160-162 (1987).
16. Friberg, T. R., Verstraeten, T. C. & Wilcox, D. K. Effects of emulsification, purity, and fluorination of silicone oil on human retinal pigment epithelial cells. *Invest Ophthalmol Vis Sci* **32**, 2030-2034 (1991).
17. Levasseur, S. D., Schendel, S., Machuck, R. W. & Dhanda, D. High-density silicone oil Densiron-68 as an intraocular tamponade for primary inferior retinal detachments. *Retina* **33**, 627-633 (2013).
18. Li, W. *et al.* Clinical complications of Densiron 68 intraocular tamponade for complicated retinal detachment. *Eye* **24**, 21-28 (2010).
19. Pagot-Mathis, V., Benouaich, X., Mathis, A., Rico-Lattes, I. & Dumoulin, A. Management of complicated retinal detachment using a heavy silicon oil as temporary tamponade. *J Fr Ophtalmol* **29**, 137-145 (2006).
20. Majid, M. *et al.* Emulsification of Densiron-68 used in inferior retinal detachment surgery. *Eye* **22**, 152-157 (2008).
21. Morescalchi, F. *et al.* Heavy silicone oil and intraocular inflammation. *BioMed Research International* **2014** (2014).
22. Coppola, M., Del Turco, C., Querques, G. & Bandello, F. Perfluorobutylpentane (F4H5) solvent-assisted silicon oil removal technique. *Retina* **37**, 793-795 (2017).
23. Ichhpujani, P., Jindal, A. & Katz, L. J. Silicone oil induced glaucoma: a review. *Graefe's Archive for Clinical and Experimental Ophthalmology* **247**, 1585-1593 (2009).
24. Asaria, R. *et al.* Silicone oil concentrates fibrogenic growth factors in the retro-oil fluid. *Br J Ophthalmol* **88**, 1439-1442 (2004).
25. Russo, A. *et al.* Heavy and standard silicone oil: intraocular inflammation. *International ophthalmology* **38**, 855-867 (2018).

Tables

Table 1

The frequency of complications in patients with long-term heavy silicone oil implantation after primary PPV operation

Complication	Rate
Raised IOP (>21mmHg)	11 (%55)
Emulsification	13 (%65)
Epiretinal Membrane	10 (%50)
Inflammation	1 (%5)
Recurrence Of Detachment	2 (%10)

Table 2

Clinical characteristics of the patients

Patient	Age/Gender	Lens Status	Silicone Oil	Time of Removal Silicone Oil (months)	Follow up time (months)	Preop VA (logMAR)	Final VA (logMAR)	Preop IOP	Postop IOP	Preop macula	Redetach
1	61/M	Phacic	Oxane HD	8	16	1.3	1.0	<21mmHG	>21mmHG	Off	No
2	83/M	Pseudophacic	Oxane HD	24	16	2.0	1.03	<21mmHG	>21mmHG	Off	No
3	54/M	Phacic	Oxane HD	9	13	1.8	0.4	<21mmHG	<21mmHG	Off	No
4	37/M	Pseudophacic	Oxane HD	6	18	2.3	0.8	<21mmHG	>21mmHG	Off	No
5	57/M	Pseudophacic	Oxane HD	16	24	2.3	0.7	<21mmHG	>21mmHG	Off	No
6	60/M	Pseudophacic	Oxane HD	8	18	0.3	0.4	<21mmHG	<21mmHG	On	No
7	65/M	Phacic	Oxane HD	12	59	0.8	0.1	<21mmHG	<21mmHG	On	No
8	73/M	Pseudophacic	Oxane HD	16	18	0.1	0.18	<21mmHG	<21mmHG	On	No
9	55/F	Pseudophacic	Oxane HD	48	30	0.3	0.1	<21mmHG	>21mmHG	On	No
10	53/M	Pseudophacic	Oxane HD	8	24	1.0	0.7	<21mmHG	>21mmHG	On	No
11	53/M	Pseudophacic	Oxane HD	8	24	1.0	0.7	<21mmHG	>21mmHG	On	No
12	74/M	Pseudophacic	Oxane HD	16	10	2.3	2.3	<21mmHG	<21mmHG	Off	Yes
13	51/M	Phacic	Oxane HD	16	15	1.7	0.7	<21mmHG	<21mmHG	Off	No
14	71/M	Phacic	Oxane HD	16	12	2.6	0.7	<21mmHG	<21mmHG	Off	Yes
15	62/M	Pseudophacic	Oxane HD	7	16	2.3	0.5	<21mmHG	<21mmHG	On	No
16	44/M	Phacic	Oxane HD	8	15	1.3	0.8	<21mmHG	>21mmHG	On	No
17	67/M	Pseudophacic	Oxane HD	28	21	0.18	0.4	<21mmHG	>21mmHG	On	No
18	70/M	Phacic	Oxane HD	9	12	0.7	0.4	<21mmHG	<21mmHG	On	No
19	68/M	Pseudophacic	Oxane HD	36	16	0.4	1.3	<21mmHG	>21mmHG	On	No
20	50/M	Phacic	Oxane HD	8	14	0.7	1.3	<21mmHG	>21mmHG	On	No

ERM: Epiretinal membrane

Figures

Figure 1

Postoperative OCT image of a case with off-macular detachment.