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Ophthalmic Outcomes After Silicone Oil Removal

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Abstract

Purpose: To describe the ophthalmic outcomes and complications after silicone oil (SO) removal. **Methods:** This nonrandomized retrospective review comprised patients who had SO removal from January 2020 to December 2022. Data collected included patient demographics, visual acuity (VA), intraocular pressure (IOP), initial tamponade, indication for SO placement, duration of SO in the eye, indication for SO removal, cataract progression, rates of retinal redetachment, cornea-related complications, additional surgical interventions, and other complications. **Results:** The study comprised 107 eyes (mean age, 56.6 years; 67% men). The most common indications for SO tamponade were rhegmatogenous retinal detachment (RRD), RRD with proliferative vitreoretinopathy (PVR), and tractional RD. The mean SO tamponade duration was 9.3 months and was longer for patients who did not have redetachment than for those who had detachment (10 months vs 6.8 months; $P = .024$). The mean preoperative logMAR VA had significantly improved by the final follow-up (1.44 vs 1.19; $P < .001$). The mean IOP was 16.43 mm Hg preoperatively and 16.81 mm Hg at the final visit ($P = .672$). Retinal redetachment occurred in 20.6% of patients, and the anatomic success rate at the final follow-up was 86.0%. A history of recurrent detachment and PVR was not associated with increased rates of postoperative redetachment. The overall rate of hypotony was 3.7% and of ocular hypertension, 7.5%. Significant cataract progression occurred in 69% of eyes. **Conclusions:** After SO removal, there was an overall improvement in VA and a stable IOP. Cataract progression was the most common complication. Although there is a risk for redetachment after SO removal, it may not have a detrimental effect on redetachment rates with a longer duration of SO tamponade.

Keywords

silicone oil removal, retinal redetachment, cataract progression, secondary glaucoma, corneal decompensation

Introduction

The use of silicone oil (SO) as a retinal tamponade agent for retinal detachment (RD) repair was first described by Cibis et al in the early 1960s.[1] Today, it is the most frequently used tamponade agent in the surgical treatment of complex RDs, giant retinal tears, proliferative vitreoretinopathy (PVR), viral retinitis, and ocular trauma.[2–7] SO requires surgical removal, which is beneficial when a long-term tamponade is desired.

Some complications that may necessitate urgent SO removal include early spikes in intraocular pressure (IOP) caused by pupillary block, clogged glaucoma tubes, and infiltration of the trabecular meshwork by microemulsification.[8] Ocular hypertension that leads to glaucoma is another frequently described complication.[9,10] Furthermore, when SO migrates to the anterior chamber and is in contact with the corneal endothelium, corneal complications (eg, corneal edema, band keratopathy, failed corneal grafts, nonhealing epithelial defects) can occur.[11] The progression and development of cataracts are also well-documented complications of all vitrectomies.[12]

Given the long-term complications of SO, removal is typically recommended when retinal pathology is stable. SO removal carries its own set of complications, including retinal redetachment. Issues with IOP and corneal decompensation have also been described after SO removal.[12,13] In addition, there are inherent risks associated with a second surgery for SO removal.

Here, we describe the results of a retrospective study of ophthalmic outcomes after SO removal at our institution.

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Methods

The Institutional Review Board, Northwell Health, approved this retrospective study of patients who had pars plana vitrectomy, SO placement, and subsequent SO removal at Vitreoretinal Consultants of New York, Great Neck, NY, USA, from January 2020 to December 2022. Patients whose visual acuity (VA) was not obtainable were excluded.

Data collected included patient demographics, VA, IOP, initial tamponade agent, indication for SO placement, duration of SO in the eye, indication for SO removal, cataract progression, rates of retinal redetachment, cornea-related complications, additional surgical interventions, and other complications. Snellen VA was converted to logMAR notation using a formula by Moussa et al,[14] who calculated the conversion using the Excel sheet conversion tool (Microsoft Corp). Cataracts that were documented as 3+ nuclear sclerosis and 2+ posterior subcapsular were deemed visually significant. Hypotony was defined as an IOP less than 6 mm Hg. Eyes that were documented to be "soft" for IOP were assumed to have an IOP of 3 mm Hg, which was the lowest measurable value at the clinic. Ocular hypertension was defined as an IOP greater than 24 mm Hg. Further analysis was performed based on the viscosity of the SO.

Mean values are ± SD. Statistical significance was set at $P < .05$.

Results

The study comprised 107 eyes, of which 103 were deemed to have an attached retina and therefore no longer required the SO tamponade; the remaining 4 eyes had a clogged glaucoma tube or pupillary block. Fifteen eyes had SO oil migration to the anterior chamber, and 2 had significant emulsification of the SO in the anterior chamber.

Table 1 shows the patients' demographics and clinical characteristics. The mean age of the 107 patients was 56.6 ± 19.3 years; 67% were men. For all patients, the mean duration of SO tamponade was 40.4 ± 27.0 weeks (9.3 months). The initial tamponade agent was SO in 62 patients, gas in 44 patients, and air in 1 patient. The most common indications for SO tamponade were rhegmatogenous RD (RRD), RRD with proliferative vitreoretinopathy (PVR), and tractional RD (TRD). Other indications included a ruptured globe and macular hole.

Table 2 shows the changes in VA and IOP from preoperatively to 5 postoperative timepoints. The mean preoperative logMAR VA was 1.44 ± 0.68 across all groups, which significantly worsened to 2.06 ± 0.60 on postoperative day (POD) 1 and then significantly improved to 1.19 ± 0.82 at the final follow-up (both $P < .001$). The improvement in VA at the final follow-up was seen across all major subgroups (RRD, $P < .001$; RRD with PVR, $P = .008$; TRD, $P = .002$). The mean IOP was 16.43 ± 7.72 mm Hg preoperatively and 16.81 ± 6.76 mm Hg at the last visit; the difference was not statistically significant ($P = .672$).

Table 1. Patient Demographics and Characteristics.

Parameter	Value
Mean age (y) ± SD	56.6 ± 19.3
Sex, n (%)	
Male	72 (67.3)
Female	35 (32.7)
Eye, n (%)	
Right	57 (53.3)
Left	50 (46.7)
Indication for SO removal, n (%)	
Anatomic success	103 (96.3)
Pupillary block/clogged glaucoma tube	4 (3.7)
Mean duration of SO tamponade (wk) ± SD	
Overall	40.5 ± 27.0
Eyes in which retina remained attached	43.3 ± 28.4
Eyes in which retina detached	29.5 ± 17.3
Initial tamponade agent, n (%)	
SO	62 (57.9)
Gas	44 (41.1)
Air	1 (0.9)
Indication for SO, n (%)	
RRD	63 (58.9)
RRD with PVR	24 (22.4)
TRD	16 (15.0)
Ruptured globe with RD	3 (2.9)
Macular hole	1 (0.09)
Lens status, n (%)	
Phakic	53 (49.5)
Pseudophakic	42 (39.3)
Aphakic	12 (11.2)

Abbreviations: PVR, proliferative vitreoretinopathy; RD; retinal detachment; RRD, rhegmatogenous retinal detachment; SO, silicone oil; TRD, tractional retinal detachment.

Statistical significance for IOP was not achieved across subgroup analysis (RRD, $P = .856$; RRD with PVR, $P = .074$; TRD, $P = .525$). The follow-up after SO removal was at least 6 months for 86.9% of patients.

Table 3 shows the complications that occurred by the final follow-up. RD occurred in 22 eyes (20.6%). Of these, 14 eyes had SO reinsertion and 7 had gas or air tamponade; 1 patient elected to have no further treatment. The mean duration of SO was 29.5 ± 17.3 weeks (6.8 months) in eyes that had an RD after SO removal and 43.3 ± 28.4 weeks (10.0 months) in eyes in which the retina remained attached. Two eyes (9.1%) were aphakic in the recurrent RD group, while 10 (11.8%) were aphakic in the group that did not experience recurrent RD. The duration of SO in the eye was significantly longer in patients who did not have a redetachment than in those who had a detachment ($P = .024$, independent samples t test). Anatomic success, defined as an attached retina without SO, was achieved in 92 eyes (86.0%) at the final follow-up. The highest rate of detachment occurred in the RRD with PVR subgroup (6/24 eyes; 25.0%).

Table 2. Preoperative and Postoperative VA and IOP.

Parameter	Preoperative	Postoperative				
		Day 1	Week 1	Month 1	Month 6	Final Visit
LogMAR VA						
Mean ± SD	1.44 ± 0.68	2.06 ± 0.60	1.36 ± 0.78	1.17 ± 0.77	1.09 ± 0.79	1.19 ± 0.82
P value	—	.001	—	—	—	.001
IOP (mm Hg)						
Mean ± SD	16.43 ± 7.72	12.66 ± 7.93	14.97 ± 6.08	15.61 ± 5.86	17.00 ± 6.76	16.81 ± 6.76
P value	—	.23	—	—	—	.672

Abbreviations: IOP, intraocular pressure; VA, visual acuity.

Table 3. Complications By the Final Follow-up.

Subgroup	Number (%)				
	RD	Hypotony	Ocular Hypertension	Corneal Edema	Other
RRD (n = 63)	14 (22.2)	1 (1.6)	6 (9.5)	1 (1.6)	CRVO (1); NV glaucoma (1)
RRD with PVR (n = 24)	6 (25.0)	1 (4.2)	0	1 (4.2)	Iridodialysis (1)
TRD (n = 16)	1 (6.25)	1 (6.25)	1 (6.2)	0	None
Ruptured globe (n = 3)	0	0	1 (33.3)	0	Exposed patch graft (1)
Macular hole (n = 1)	1 (100.0)	1 (100.0)	0	0	None
Overall (N = 107)	22 (20.6)	4 (3.7)	8 (7.5)	2 (1.9)	—

Abbreviations: CRVO, central retinal vein occlusion; NV, neovascular; PVR, proliferative vitreoretinopathy; RD, retinal detachment; RRD, rhegmatogenous retinal detachment; TRD, tractional retinal detachment.

At the time of SO removal, 53 eyes were phakic, 42 were pseudophakic, and 12 were aphakic. Twenty-four phakic eyes had combined cataract extraction, intraocular lens (IOL) implantation, and SO removal. Of the remaining 29 phakic eyes, 17 remained phakic at 6 months and 8 had a documented visually significant cataract. The other 12 eyes had extraction of a cataract (all assumed to be visually significant) before 6 months. Therefore, significant cataract progression occurred in 69% of eyes.

Overall, the rate of hypotony and of ocular hypertension was 3.7% and 7.5%, respectively. Two eyes developed persistent corneal edema (at least 2+ stromal edema), and 2 other eyes had concurrent penetrating keratoplasty with SO removal. No eye required additional surgical intervention for IOP or cornea-related complications. Other complications included an exposed suture that required a patch graft in 1 eye with a ruptured globe, neovascular glaucoma and hyphema in 1 eye, iridodialysis in 1 eye, and central retinal vein occlusion in 1 eye.

Of the 62 eyes for which SO viscosity was recorded, 61.3% received 5000 centistoke (cs) SO and 38.7% received 1000 cs SO. There were no statistically significant differences in the preoperative logMAR VA (1.54 vs 1.29; $P = .19$), postoperative logMAR VA (1.34 vs 1.12; $P = .30$), preoperative IOP (15.89 mm Hg vs 17.75 mm Hg; $P = .44$), postoperative IOP (15.63 mm Hg vs 15.74 mm Hg, $P = .95$), or rate of redetachment (78.9% vs 83.3%; $P = .67$) between eyes with 5000 cs SO and eyes with 1000 cs SO.

Binary logistic regression, adjusting for potential confounding factors including age, sex, macula-on RD, PVR, and preoperative VA, determined that a history of recurrent detachment did not increase the odds of postoperative redetachment ($P = .26$) and that PVR was not associated with higher rates of redetachment ($P = .513$).

Conclusions

SO offers several advantages in the management of RD. Physical properties, such as a high viscosity and buoyancy, provide a long-lasting tamponade that may aid in retinal reattachment.[15] The clinical advantages of SO include a higher rate of retinal reattachment and fewer complications compared with sulfur hexafluoride gas in patients with severe PVR.[16] SO is also optically clear, allowing patients to achieve better VA in the immediate postoperative period and the surgeon to better evaluate the status of the retina immediately. The major disadvantage of using SO is the need for second surgery for its removal and thus the possibility that the retina will redetach as well as that the risk for glaucoma and corneal decompensation increases. The removal of SO is usually recommended when the retina remains stable, typically between 3 months and 6 months after its insertion.[17–19] The reported detachment rates after SO removal vary between 0% and 33%.[7] In our study, the redetachment rate was 20.6%, which is about the average of the rates reported in the literature.

Improvement in VA can typically be expected after SO removal because the optical properties of SO can significantly change the patient's refractive status by up to 5.00 D to 9.00 D.[1]

In our cohort, all major subgroups had a significant improvement in vision at the final follow-up if the retina had remained attached. The decline in VA in the early postoperative period may be attributed to the insertion of gas or air, postoperative inflammation, or vitreous hemorrhage. Improvement in VA after SO removal can also be partially attributed to simultaneous cataract extraction with IOL insertion, which is a confounding variable. The majority of patients in this study were pseudophakic or had simultaneous cataract extraction and SO removal. Other studies have shown that good preoperative VA, pseudophakia, and SO removal combined with cataract surgery and IOL insertion are predictors of better postoperative VA.[20–22]

In this study, the mean duration of SO in the eye before its removal was 9.3 months. Eyes that had SO removal approximately 6 months after insertion were at a significantly higher risk for redetachment than those that had SO removal approximately 10 months after insertion. Leaving SO in the eye for longer periods before removal may provide the best chance for retinal attachment postoperatively. However, this must be balanced with the higher risk for IOP-related complications and corneal decompensation with a longer duration. Unexplained vision loss after SO removal has an incidence of up to 30% and has been correlated with a longer duration of SO in the eye.[23–25] Other procedures performed simultaneously with SO removal, such as endolaser application or membrane peeling, were not analyzed except for cataract extraction. It is unclear what effects these other interventions had on visual outcomes and detachment rates in this cohort. Endolaser treatment was not routinely performed in this study. The results of 360-degree endolaser application on final anatomic success rates have been mixed.[26,27]

Cataract formation is the most common complication of vitrectomies, with up to 100% of eyes developing cataract within 2 years postoperatively.[28] In our study, 45% of the phakic eyes had combined phacoemulsification and SO removal. A small number of eyes remained phakic on POD1; however, the majority developed a visually significant cataract or had cataract removal by the 6-month follow-up. Cataract progression after vitrectomy may be a result of intraoperative inflammation and oxidative stress on the lens.[29,30] Additional vitrectomies may increase the cumulative effect.

There were no significant changes in IOP before or after SO removal in each major subgroup. The overall rates of hypotony and ocular hypertension were relatively low (3.7% and 7.5%, respectively). The reported incidence of transient hypotony after SO removal is 5% to 40% and may be associated with a lower preoperative IOP and longer axial length.[31–34] It has been hypothesized that ciliary body shutdown and an inflammation-induced prostaglandin-mediated decrease in aqueous production are 2 causes of hypotony, which typically spontaneously improves.[33] The rate of persistent ocular hypertension is reported to be 9% to 16%.[13,35] In most cases, the IOP normalizes without intervention; however, significant damage to the trabecular meshwork or the persistent presence of microemulsified oil within the trabecular meshwork may prevent normalization of the IOP. In a study by Wesolek-Czernik,[36] 7% of patients required incisional glaucoma surgery after SO removal.

One theory is that corneal decompensation occurs because the SO in the anterior chamber tamponades against the endothelium and when removed, there is persistent stromal hydration. Although the incidence of corneal decompensation reported in the literature is 3% to 63%,[7,37] it occurred in only 2 eyes (1.9%) in our study. One eye had an anterior chamber IOL, and the other had a glaucoma tube in the anterior chamber and a posterior chamber IOL. Neither eye required corneal transplantation. The rate of keratopathy has been associated with a longer duration of SO in the eye.[35,38]

Given its retrospective nature, this study has several limitations. Eight surgeons performed SO removal, and the variability in the surgeons' techniques and decision-making for SO removal may have skewed the data. Other confounding variables, such as instrument gauge and simultaneous procedures, were not available or varied depending on surgeon preference. Centistoke information was also unavailable for all patients; thus, definitive conclusions cannot be made from these results. For example, although previous studies have suggested that 1000 cs SO leads to more emulsification or that 5000 cs SO leads to higher IOPs,[39,40] neither occurred in our study. Moreover, further statistical analysis of variables affecting the rate of recurrent redetachment after SO removal was limited because of the low number of eyes with this complication. Future studies with a larger sample or a pooled sample may provide further insight. Last, many patients were not followed on a standardized schedule and were lost to follow-up.

In conclusion, overall this large retrospective study shows that retinal redetachment remains a risk after SO removal; however, there may be significant improvement in VA if the retina remains attached. There were no significant issues related to IOP or corneal complications in this cohort. Although one may consider leaving the SO in the eye for longer periods to provide the best chance for anatomic success, this should be weighed against the risks of SO-related complications. Each case must be individualized, and patients must be properly informed of the risks and benefits of SO removal so that the physician and patient can make a shared decision on the best treatment method. Larger studies will be necessary to further understand how to best treat these complex cases.

Ethical Approval

Ethical approval for this study was obtained from the Institutional Review Board, Northwell Health.

Statement of Informed Consent

Informed consent was not required for this retrospective review because all patient data were de-identified.

Declaration of Conflicting Interests

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