


Perfluorocarbon-Assisted Emulsified Silicone Oil Removal: A Simple and Effective Technique

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Purpose: To describe and evaluate a perfluorocarbon liquid (PFCL)-assisted technique for removal of emulsified silicone oil following vitreoretinal surgery.

Methods: This retrospective interventional case series conducted at a single vitreoretinal center included 20 eyes with significant emulsified silicone oil following long-term tamponade. PFCL was used intraoperatively to mobilize and evacuate residual silicone oil droplets. Clinical outcomes included residual emulsified oil, intraocular pressure, and best-corrected visual acuity over a mean follow-up of 24.2 months.

Results: At final follow-up, 17 eyes (85%) showed complete clearance of visible emulsified silicone oil. Sparse microscopic droplets persisted in 3 eyes (15%) without clinical significance. No eye developed elevated intraocular pressure (>21 mmHg) or corneal complications. Best-corrected visual acuity improved or remained stable in all eyes, with 65% achieving an improvement of ≥ 2 Snellen lines.

Conclusion: PFCL-assisted washout may represent a practical adjunctive technique for managing emulsified silicone oil in challenging cases, achieving high rates of clinical clearance with a favorable safety profile. Larger prospective studies are required to validate these findings.

Plain Language Summary: Silicone oil is commonly used during retinal surgery to support healing, but over time it can break into tiny droplets that are difficult to remove and may cause increased eye pressure or vision problems. Traditional removal methods often fail to completely clear these droplets.

This study describes a surgical technique that uses a heavy liquid, called perfluorocarbon liquid, to more effectively wash out emulsified silicone oil from the eye. The technique was applied in 20 patients who developed significant silicone oil emulsification after previous retinal surgery.

In most patients, visible silicone oil droplets were successfully removed. Eye pressure remained stable, and vision either improved or stayed the same during long-term follow-up. No serious complications related to the technique were observed.

This approach may help surgeons remove emulsified silicone oil more safely and thoroughly, potentially reducing long-term eye complications for patients.

Keywords: silicone oil emulsification, perfluorocarbon liquid, vitreoretinal surgery, intraocular pressure, anterior chamber, emulsified oil removal

Introduction

Silicone oil is widely used in retinal surgery as a long-term tamponade but may emulsify over time into tiny droplets dispersed throughout the anterior and posterior segments of the eye,¹ particularly when retained for prolonged periods.

It has been reported in up to 70% of eyes when silicone oil remains in situ for more than six months, with most cases developing within 6–12 months following vitreoretinal surgery.²

These droplets may obstruct aqueous outflow pathways, increase intraocular pressure (IOP), and scatter light, thereby reducing visual clarity.² Migration into the anterior chamber may damage the corneal endothelium and impair visual

acuity.³ In extensive cases, the droplets themselves can significantly compromise vision,³ and subretinal migration has also been reported.⁴

Conventional removal methods, including suction and fluid–air exchange techniques, may not completely eliminate dispersed silicone oil droplets.⁴ This study therefore describes a perfluorocarbon liquid (PFCL)-assisted technique designed to facilitate more effective removal of emulsified silicone oil ([Video S1](#)).

Patients and Methods (Surgical Technique)

Study Design

This was a retrospective interventional case series. The study was approved by the local ethics committee, and informed consent was obtained from all participants.

Inclusion Criteria

Inclusion criteria comprised eyes with clinically significant emulsified silicone oil following long-term silicone oil tamponade that underwent silicone oil removal.

Surgical Technique

All procedures were performed by a single vitreoretinal surgeon (OOA) using a standard 23-gauge pars plana vitrectomy platform. Perfluorocarbon liquid (perfluorodecalin) was used as the intraoperative PFCL agent. Infusion pressure was maintained between 25–30 mmHg during irrigation steps, while infusion flow was temporarily stopped during PFCL injection.

After removal of emulsified silicone oil from the anterior chamber ([Figure 1A](#)) and removal of the primary silicone oil, the following steps were performed. Perfluorocarbon liquid (PFCL) was gently injected to displace residual oil droplets toward the anterior segment ([Figure 1B](#)). Injection was continued until the PFCL interface reached the posterior surface of the intraocular lens (IOL), which served as the anatomical endpoint for filling. Particular care was taken to

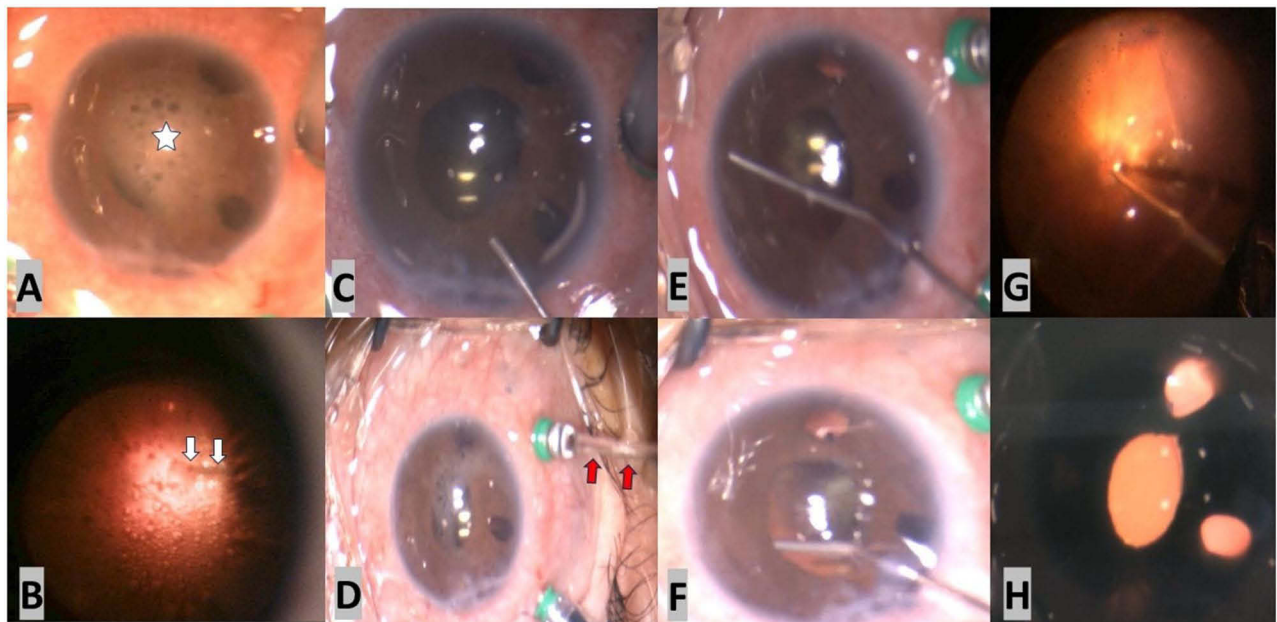


Figure 1 Intraoperative steps of perfluorocarbon liquid (PFCL)-assisted emulsified silicone oil removal. **(A):** Anterior chamber with emulsified droplets (white star). **(B):** PFCL injection using a non-silicone cannula (white arrows). **(C):** Active irrigation of the anterior chamber and iris. **(D):** Passive outflow via non-valve trocars (red arrows). **(E):** Angle irrigation with a blunt cannula. **(F):** Sub-iris irrigation with a blunt cannula. **(G):** PFCL aspiration. **(H):** Retro-illumination confirming clearance of emulsified silicone oil droplets.

Table 1 Preoperative and Postoperative Clinical Outcomes Following PFCL-Assisted Emulsified Silicone Oil Removal (n = 20 Eyes)

Outcome Measure	Preoperative Value (mean ± SD)	Final Postoperative Value (mean ± SD)	Change	p-value
BCVA (Snellen lines)	Baseline: 0.05 ± 0.03 (approximately 20/400)	0.21 ± 0.12 (approximately 20/95)	Improved by ≥ 2 lines in 13/20 eyes (65%)	p < 0.01
IOP (mmHg)	18.6 ± 2.5	15.9 ± 2.1	-2.7 mmHg average	p = 0.04
Extended lavage time (minutes)	-	27 ± 3	-	-

Abbreviations: SD, standard deviation; BCVA, best-corrected visual acuity; IOP, intraocular pressure.

prevent PFCL migration into the anterior chamber. The trocar valves were then removed to allow free fluid movement and passive egress (Figure 1D).

The anterior chamber was thoroughly irrigated through a small corneal incision using an irrigating cannula, which lavaged the aqueous drainage pathways, iris, and surrounding structures (Figure 1C–F). Extended irrigation, lasting at least 30 minutes, facilitated clearance of residual droplets. Finally, PFCL was removed, leaving a clear intraocular environment with no visible silicone oil residue (Figure 1G and H).

Clinical Outcomes and Follow-Up

This technique was applied in 20 eyes of 20 patients with significant emulsified silicone oil following long-term tamponade. Primary outcomes were residual emulsified silicone oil on slit-lamp examination, intraocular pressure, and best-corrected visual acuity. The mean interval since primary vitrectomy was 8.6 ± 2.3 months. At final follow-up, slit-lamp examination and fundus imaging confirmed that 17 of 20 eyes (85%) showed no visible residual emulsified droplets. The remaining 3 eyes (15%) demonstrated sparse microscopic droplets in the inferior vitreous base or anterior chamber angle, which were clinically insignificant (Figures 1A–H).

None of the patients developed elevated intraocular pressure (>21 mmHg) or required additional surgical intervention. Best-corrected visual acuity (BCVA) either improved or remained stable in all eyes, with 13 eyes (65%) showing improvement of ≥ 2 Snellen lines. The anterior chambers remained clear, and no cases of corneal decompensation, fibrin reaction, or recurrent inflammation were observed. The average increase in intraoperative time attributable to extended lavage was 27 ± 3 minutes (Table 1).

Patients were followed clinically with slit-lamp biomicroscopy, intraocular pressure measurement, and fundus examination for a mean duration of 24.2 months.

Statistical Analysis

Descriptive statistics were used to summarize clinical data. Preoperative and postoperative outcomes were compared using paired t-tests after confirming normal distribution of the variables. Normality of continuous variables was assessed prior to parametric testing. A p-value <0.05 was considered statistically significant.

Discussion

Silicone oil emulsification remains a persistent challenge following retinal detachment repair, with incomplete removal contributing to long-term complications, such as secondary glaucoma, corneal endothelial damage, and visual haze. Conventional removal techniques, including fluid–air exchange, direct aspiration, or irrigation, frequently fail to eliminate dispersed microdroplets, especially those retained in the anterior chamber angle or beneath the iris (Figure 1A).

The PFCL-assisted approach described here creates a biomechanically favorable environment for mobilizing trapped emulsified oil. Owing to its high specific gravity, PFCL facilitates anterior displacement of oil droplets, enabling more complete evacuation through passive outflow via the trocars (Figures 1B–D). Removal of the trocar valves establishes a passive washout system, wherein a steady infusion current promotes continuous clearance of residual droplets.

Additionally, anterior chamber lavage performed with a dedicated irrigating cannula ensures targeted cleaning of high-risk retention zones, specifically the trabecular meshwork, iris root, and posterior iris plane (Figures 1C–F). In contrast to traditional methods that focus primarily on the posterior segment, this combined posterior-anterior clearance strategy comprehensively addresses the entire intraocular compartment. This combined workflow may represent a practical refinement of previously described PFCL-assisted techniques.

The prolonged lavage time (approximately 30 minutes) may raise concerns; however, our long-term follow-up demonstrates that this additional intraoperative effort yields sustained benefits. These include the absence of post-removal IOP rise, improved visual function, and a reduced need for further interventions (Table 1).

Removal of emulsified silicone oil remains a major challenge for vitreoretinal surgeons due to the absence of a standardized technique. Once silicone oil has emulsified into small droplets, complete clearance becomes extremely difficult. Once emulsified, droplets disperse throughout the vitreous cavity and the anterior chamber, where traditional removal methods are largely ineffective.⁴ If not adequately addressed, complications, including IOP elevation, corneal decompensation, and persistent visual impairments, may develop.

The procedure described here offers a more effective approach by employing PFCL as a mechanical adjunct. Because PFCL is heavier than both water and silicone oil, therefore, it can displace dispersed oil droplets into an open area where they are more easily flushed out. Unlike fluid–air exchange, which often leaves minute droplets adherent to intraocular structures, PFCL actively evacuates and directs emulsified oil towards the anterior chamber, thereby facilitating more thorough clearance.⁵

In standard vitrectomy, the trocar valve acts as a barrier to droplet clearance, trapping emulsified silicone oil within the eye and impeding complete removal. In the present approach, this limitation is addressed by removing the trocar valves, thereby establishing a passive drainage pathway. The presence of PFCL up to the posterior surface of the IOL further prevents retrograde passage of droplets. All eyes in this series were pseudophakic, allowing the IOL to serve both as an anatomical barrier and as a reliable landmark for controlled PFCL filling. Furthermore, prolonged irrigation with an irrigating cannula engaged through a corneal incision ensures clearance of residual oil from the anterior chamber angle, iris surface, sub-iris space, trabecular meshwork, and posterior segment (Supplemental video 1; Figures 1C–F). These combined steps are critical for preventing long-term complications of emulsified silicone oil, such as secondary glaucoma,^{1,2} glare, diminished contrast sensitivity due to light scatter, and impaired vision.³

One possible concern is the extended washing time, which extends the procedure by 20–30 minutes. Although this duration exceeds that of standard oil removal, it minimizes residual droplet retention and the need for additional interventions. By contrast, shorter cleaning durations may leave residual emulsified oil requiring subsequent procedures. Thus, the additional operative time in this technique is justified by its long-term advantages.

Although prolonged lavage may theoretically raise concerns regarding intraocular manipulation or PFCL exposure, no PFCL-related complications such as subretinal infusion, inflammation, or corneal toxicity were observed in this series. Complete removal of PFCL at the end of the procedure remains essential to avoid potential complications.

On long-term follow-up (>2 years), none of the patients developed high IOP, the anterior chambers remained clear, and visual function improved. Although a few microscopic oil droplets persisted, they were clinically insignificant and did not cause measurable vision impairment.

Future studies should aim to quantify oil clearance rates following PFCL-assisted washout in comparison with traditional techniques, thereby providing objective evidence to establish this method as a potential standard of care for emulsified silicone oil management.

Given the limited sample size, the statistical power of the study is inherently restricted, and the observed outcomes should be interpreted cautiously as preliminary clinical observations rather than definitive evidence of superiority.

The present study is limited by its retrospective design, relatively small sample size, and the absence of objective imaging-based quantification of residual silicone oil droplets. Future studies incorporating anterior segment OCT or ultrasound biomicroscopy could provide more precise measurement of droplet clearance.

Conclusion

PFCL-assisted washout achieved high rates of clinical clearance of emulsified silicone oil (85% without visible droplets) in this case series of challenging eyes. No PFCL-related complications were observed, and intraocular pressure remained stable during follow-up. These findings suggest that PFCL-assisted washout may represent a practical adjunctive technique for managing emulsified silicone oil; however, the results should be interpreted as preliminary and hypothesis-generating, and larger prospective comparative studies are required to further evaluate its efficacy and safety.

Data Sharing Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was reviewed and approved by the local Ethics Committee of Ibinsina Modern Eye and Retina Center, Erbil, Iraq (approval number: **IMERC-VR-2025-SO**). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to inclusion in the study. All patients provided consent for the use and publication of clinical data and intraoperative images.

Consent for Publication

Written informed consent was obtained from all participants for publication of clinical details, images, and surgical videos.

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Disclosure

The author declares no conflicts of interest related to this work.

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