

Silicone Oil-Induced Secondary Glaucoma After Pars Plana Vitrectomy – Case Report and Literature Review

Rafał Woś¹, Rafał Leszczyński¹, Ewa Mrukwa-Kominek^{1,2}

¹ Department of Ophthalmology, Prof. K. Gibiński University Clinical Center, Medical University of Silesia in Katowice, Poland
Head: Professor Dorota Wyględowska-Promieńska, PhD, MD

² Department of Ophthalmology, Faculty of Medical Sciences in Katowice, Medical University of Silesia in Katowice, Poland
Head: Professor Dorota Wyględowska-Promieńska, PhD, MD

Abstract:

Introduction: Silicone oil is a widely used intraocular tamponade in complex retinal detachment surgery. However, its use may lead to secondary glaucoma, with reported incidence ranging from 5% to 56%. The pathogenesis is multifactorial, including pupillary block, emulsification, trabecular obstruction, and chronic inflammation. This report presents a case of secondary glaucoma and reviews available treatment strategies, including evolving cyclodestructive procedures.

Case Presentation: A 44-year-old pseudophakic male with bilateral megalocornea presented with chronic, recurrent retinal detachment in the right eye and vitreous haemorrhage accompanied by a dislocated intraocular lens in the left eye. Pars plana vitrectomy with silicone oil endotamponade was performed in the right eye, while the left eye underwent pars plana vitrectomy with SF₆ gas tamponade and implantation of an Artisan aphakic intraocular lens. Postoperatively, right eye developed elevated intraocular pressure up to 47 mmHg, requiring intensive medical therapy. After silicone oil removal, intraocular pressure remained uncontrolled (35 mmHg), necessitating diode transscleral cyclophotocoagulation. The procedure achieved sustained intraocular pressure control (17 mmHg). Left eye also exhibited transient intraocular pressure elevation but stabilised with pharmacotherapy.

Discussion: Silicone oil-induced glaucoma remains a significant therapeutic challenge. While medical therapy is the first-line treatment, it often fails to achieve long-term control. Surgical options include silicone oil removal and cyclodestructive techniques. Transscleral cyclophotocoagulation, especially with slow coagulation or micropulse protocols, shows favourable outcomes in refractory cases by minimising collateral tissue damage while effectively reducing aqueous production.

Conclusions: Secondary glaucoma caused by silicone oil requires early detection and individualized management. When medical therapy is insufficient, timely silicone oil removal and transscleral cyclophotocoagulation – particularly newer protocols – offer promising results in achieving pressure control and preserving vision.

Key words:

glaucoma, secondary glaucoma silicone oil, vitrectomy, cyclophotocoagulation, micropulse.

Introduction

Silicone oil (SO) is a long-established intraocular tamponade used in complex retinal detachment surgery. Secondary glaucoma is a well-documented complication of intraocular silicone oil, with reported incidence ranging from 6% to 56% of cases [1–3]. Improvements in vitreoretinal techniques have reduced this risk; for example, Al-Jazzaf reported an incidence of 11% for sustained intraocular pressure (IOP) elevation after silicone oil injection in a large series [3]. Nonetheless, silicone oil-induced glaucoma can occur at any time postoperatively – from early weeks to months or even years after vitrectomy – and can lead to significant vision loss if not recognised and treated [4–6].

The mechanisms of silicone oil glaucoma are multifactorial. Four classic pathogenetic mechanisms have been established: 1. pupillary block by a silicone oil bubble causing iris bombe and secondary angle closure; 2. overfilling of the eye with silicone oil (particularly in aphakia), leading to total anterior chamber oil fill and open-angle outflow obstruction; 3. emulsification of the oil into microscopic droplets that infiltrate and obstruct the trabecular meshwork; and 4. chronic inflammation or exacerbation of pre-existing glaucoma [6]. Additional contributors include peripheral anterior synechiae from prolonged contact, neovascularisation of the angle (rubeosis iridis), and ghost cell glaucoma in eyes with concomitant vitreous haemorrhage [7, 8].

In an analysis of 150 eyes after pars plana vitrectomy (PPV), the incidence of glaucoma after silicone oil tamponade was 40%, with a median onset time of 14 days (range: 1 day to 18 months). In approximately 70% of these cases, the intraocular pressure elevation was directly attributed to silicone oil-related mechanisms such as pupillary block or anterior chamber migration.

Furthermore, the presence of rubeosis iridis was identified as a significant independent risk factor for the development of secondary glaucoma in eyes with silicone oil endotamponade, with an odds ratio of 10.8 [1].

In chronic cases, silicone oil migration into the optic nerve may cause direct toxic or obstructive neuropathy alongside pressure-related damage, as demonstrated histopathologically by Shields et al. [9]. Identified risk factors include aphakia, diabetes mellitus, anterior chamber oil presence, and prolonged oil retention [10]. Due to its potentially sight-threatening consequences, secondary glaucoma from SO requires careful monitoring and proactive management.

In the presented case, the patient developed elevated intraocular pressure (IOP) in the right eye (RE) following vitrectomy with silicone oil injection. The condition required intensive IOP-lowering pharmacotherapy, frequent monitoring, and ultimately transscleral cyclophotocoagulation (TSCPC) due to persistent pressure instability.

Case Presentation

Patient History

A 44-year-old male with bilateral megalocornea and pseudophakia presented to our emergency department in August 2024 with acute visual decline in his left eye (LE) of 3 days' duration. His ocular history included retinal detachment repair in the RE and cataract extraction with intraocular lens (IOL) implantation in the LE performed in 2014. He denied any recent trauma.

Initial Clinical Course

Initial examination in August 2024 revealed chronic, recurrent retinal detachment in the RE, while the LE exhibited vitreous hemorrhage with dislocated intraocular lens IOL. B-scan ultrasonography confirmed total retinal detachment in the RE and numerous medium-reflective echoes in the posterior vitreous chamber of the LE.

The patient underwent sequential vitreoretinal surgeries:

- August 2024 – PPV with silicone oil endotamponade for recurrent detachment in the RE,
- September 2024 – PPV with SF6 gas tamponade, Artisan aphakic IOL implantation, and endolaser photocoagulation for primary detachment in the LE.

Postoperative Complications

The early postoperative period was complicated by refractory intraocular hypertension in the RE, with IOP peaking at 47 mmHg in August 2024. This required intensive medical therapy: topical timolol 0.5% (twice daily), brimonidine 0.2% (3 times daily), brinzolamide 1% (twice daily), and oral acetazolamide (500 mg/ day).

Despite initial stabilisation (IOP 20–25 mmHg), the RE developed recurrent hypertension after silicone oil removal in March 2025 (IOP 35 mmHg in April 2025). The LE maintained anatomical stability but experienced IOP spikes during medication lapses, reaching 42 mmHg in late August 2024.

Definitive Intervention

In April 2025, transscleral diode cyclophotocoagulation (TSCPC) with anterior chamber washout was performed for the RE due to uncontrolled IOP. This achieved immediate reduction to 16 mmHg, with sustained control at 17 mmHg by May 2025.

Outcome

At final follow-up (May 2025):

- RE maintained IOP 17 mmHg on topical dorzolamide 2% twice daily, brimonidine 0.2% twice daily, loteprednol 0.5% twice daily;
- LE achieved IOP normalization (17–21 mmHg) on topical dorzolamide 2% three times daily, brimonidine 0.2% twice daily, and timolol 0.5% twice daily;
- 250 mg/ day oral acetazolamide was sustained.

Discussion

Secondary glaucoma caused by silicone oil presents a therapeutic challenge requiring a combination of medical and surgical strategies. Initial management focuses on medical therapy to lower IOP and alleviate acute risk to the optic nerve. First-line measures include cycloplegic agents and topical corticosteroids to reduce inflammation, combined with aqueous suppressants (topical beta-blockers, carbonic anhydrase inhibitors, alpha2-agonists) [6]. Systemic acetazolamide or hyperosmotic agents are reserved for acute pressure spikes. However, medical treatment alone often fails to control IOP adequately. Honavar et al. documented that medications achieved satisfactory IOP control in only 30% of eyes with silicone oil-induced glaucoma [1]. Consequently, surgical in-

tervention is indicated if IOP remains elevated despite maximal medical therapy [12].

Silicone oil removal is a fundamental intervention once retinal stability is confirmed, as it addresses the root cause of IOP elevation in many cases. Removal eliminates pupillary block and reduces the burden of emulsified droplets obstructing the trabecular meshwork [13]. Jonas et al. reported IOP normalisation in 93% of eyes after silicone oil removal [14]. However, in chronic cases glaucoma may persist despite the procedure. These discrepancies relate to irreversible trabecular damage: experimental and clinical studies confirm that long-term exposure to emulsified oil causes trabecular meshwork degeneration (fibrosis, sclerosis, and collapse of trabecular lamellae). Early SO removal (within weeks to months) is therefore recommended to prevent permanent outflow pathway damage, but this must be balanced against the risk of retinal redetachment [6, 15].

For aphakic or pseudophakic eyes, an inferior peripheral iridectomy is a critical prophylactic measure to prevent pupillary block glaucoma [16]. Ando introduced the concept of a surgical iridectomy at the 6 o'clock position to allow aqueous humour to bypass the silicone oil bubble [17]. This “m. Ando iridotomy” is now standard practice during vitrectomy with silicone oil in aphakic eyes.

Transscleral cyclophotocoagulation has emerged as a cornerstone treatment for medically uncontrolled glaucoma following pars plana vitrectomy with SO. Conventional continuous-wave diode TSCPC reduces aqueous production by ablating ciliary processes. Success rates (defined as IOP ≤ 21 mmHg with or without medications) range from 66% to 82% at one year [18, 19]. Ahmed et al. reported a mean IOP reduction from 39.3 mmHg to 19.1 mmHg, with 78% of eyes achieving target pressure [20]. However, efficacy declines with long-term oil retention: Sivagnanavel et al. observed only 44% success (IOP < 22 mmHg) in eyes with silicone oil tamponade > 1 year, despite aggressive treatment [21].

In recent years, refinements of cyclophotocoagulation techniques have improved safety and efficacy for silicone oil-related glaucoma. One such modification is the “slow coagulation” TSCPC protocol, which delivers laser energy at lower power over longer durations per spot (4 seconds at 1250 mW for dark or light brown irises, instead of 2 seconds at 1750 mW) [22]. By avoiding the instantaneous high-energy bursts that cause explosive tissue disruption, slow coagulation aims to achieve a controlled ciliary ablation with less collateral damage. Clinical results are encouraging: Khodeiry et al. treated 18 eyes with SO-induced glaucoma using slow CW-TSCPC and achieved a 50% mean IOP reduction (from approx. 30 mmHg to 15 mmHg) at 12 months, with a 72% success rate and no significant vision loss or hypotony complications [23].

Another advance is micropulse transscleral cyclophotocoagulation (MP-TSCPC), a technique that delivers a 810 nm diode laser in a rapid sequence of short “on” pulses and “off” resting periods, rather than a continuous beam [24]. The micropulse mode prevents thermal buildup in the tissue, theoretically reducing ciliary body destruction and inflammatory byproducts. Originally developed for primary open-angle glaucoma, micropulse TSCPC has recently been applied to secondary glaucomas including SO-induced glaucoma. In a prospective study of 33 eyes with uncontrolled glaucoma after PPV with SO, Zbiba et al. reported that a single session of MP-TSCPC lowered the mean IOP from ~ 38 mmHg to ~ 19 mmHg (a $\sim 45\%$ reduction), with the effect sustained at 12-month follow-up [25].

Conclusions

Silicone oil-induced glaucoma remains a significant complication of retinal detachment surgery. Preventive measures (e.g., in-

ferior iridectomy in aphakia) and timely interventions – including SO removal when feasible and cyclodestructive procedures – are critical to managing IOP elevation and preserving vision. Innovations such as slow-coagulation and micropulse TSCPC offer less invasive yet effective treatment options.

Disclosure

Conflict of interests: none declared

Funding: no external funding

Ethics approval: Not applicable.

References:

- Honavar SG, Goyal M, Majji AB, et al.: *Glaucoma after pars plana vitrectomy and silicone oil injection for complicated retinal detachments*. Ophthalmology. 1999 Jan; 106(1): 169–176; discussion 177. doi: 10.1016/S0161-6420(99)90017-9.
- Riedel KG, Gabel VP, Neubauer L, et al.: *Intravitreal silicone oil injection: complications and treatment of 415 consecutive patients*. Graefes Arch Clin Exp Ophthalmol. 1990; 228: 19–23. <https://doi.org/10.1007/BF02764284>.
- Al-Jazzaf AM, Netland PA, Charles S: *Incidence and management of elevated intraocular pressure after silicone oil injection*. J Glaucoma. 2005 Feb; 14(1): 40–46. doi: 10.1097/01.jig.0000145811.62095.fa.
- Grzybowski A, Pieczynski J, Ascaso FJ: *Neuronal complications of intravitreal silicone oil: an updated review*. Acta Ophthalmologica. 2014; 92: 201–204. <https://doi.org/10.1111/aos.12212>
- Tayyab HA, Iqbal K, Rahman FU, et al.: *The Emulsification of Silicone Oil 5000 cs in Patients With Retinal Detachment*. Cureus. 2023 Jun 10; 15(6): e40205. doi: 10.7759/cureus.40205.
- Ichhpujani P, Jindal A, Jay Katz L: *Silicone oil induced glaucoma: a review*. Graefes Arch Clin Exp Ophthalmol. 2009 Dec; 247(12): 1585–1593. doi: 10.1007/s00417-009-1155-x. Epub 2009 Aug 14.
- Leaver PK, Grey RH, Garner A: *Silicone oil injection in the treatment of massive preretinal retraction. II. Late complications in 93 eyes*. Br J Ophthalmol. 1979 May; 63(5): 361–367. doi: 10.1136/bjo.63.5.361.
- Federman JL, Schubert HD: *Complications associated with the use of silicone oil in 150 eyes after retina-vitreous surgery*. Ophthalmology. 1988 Jul; 95(7): 870–876. doi: 10.1016/s0161-6420(88)33080-0.
- Shields CL, Eagle RC Jr.: *Pseudo-Schnabel's cavernous degeneration of the optic nerve secondary to intraocular silicone oil*. Arch Ophthalmol. 1989 May; 107(5): 714–717. doi: 10.1001/archoph.1989.01070010732036.
- Henderer JD, Budenz DL, Flynn HW, et al.: *Elevated Intraocular Pressure and Hypotony Following Silicone Oil Retinal Tamponade for Complex Retinal Detachment: Incidence and Risk Factors*. Arch Ophthalmol. 1999; 117(2): 189–195. doi:10.1001/archoph.117.2.189.
- Nguyen QH, Lloyd MA, Heuer DK, et al.: *Incidence and management of glaucoma after intravitreal silicone oil injection for complicated retinal detachments*. Ophthalmology. 1992 Oct; 99(10): 1520–1526. doi: 10.1016/s0161-6420(92)31771-3.
- Budenz DL, Taba KE, Feuer WJ, et al.: *Surgical management of secondary glaucoma after pars plana vitrectomy and silicone oil injection for complex retinal detachment*. Ophthalmology. 2001 Sep; 108(9): 1628–1632. doi: 10.1016/s0161-6420(01)00658-3.
- Moisseiev J, Barak A, Manaim T, et al.: *Removal of silicone oil in the management of glaucoma in eyes with emulsified silicone*. Retina. 1993; 13(4): 290–295. doi: 10.1097/00006982-199313040-00004.
- Jonas JB, Knorr HL, Rank RM, et al.: *Intraocular pressure and silicone oil endotamponade*. J Glaucoma. 2001 Apr; 10(2): 102–108. doi: 10.1097/00061198-200104000-00006.
- Flaxel C, Mitchell S, Aylward G: *Visual outcome after silicone oil removal and recurrent retinal detachment repair*. Eye. 2000; 14: 834–838. <https://doi.org/10.1038/eye.2000.232>.
- Ando F: *Intraocular hypertension resulting from pupillary block by silicone oil*. Am J Ophthalmol. 1985 Jan 15; 99(1): 87–88. doi: 10.1016/s0002-9394(14)75878-7.
- Beekhuis WH, Ando F, Zivojnović R, et al.: *Basal iridectomy at 6 o'clock in the aphakic eye treated with silicone oil: prevention of keratopathy and secondary glaucoma*. Br J Ophthalmol. 1987 Mar; 71(3): 197–200. doi: 10.1136/bjo.71.3.197.
- Bloom PA, Tsai JC, Sharma K, et al.: *"Cyclodiode": Trans-Scleral Diode Laser Cyclophotocoagulation in the Treatment of Advanced Refractory Glaucoma*. Ophthalmology. 1997; 104: 1508–1520. [https://doi.org/10.1016/S0161-6420\(97\)30109-2](https://doi.org/10.1016/S0161-6420(97)30109-2).
- Han SK, Park KH, Kim DM, et al.: *Effect of diode laser trans-scleral cyclophotocoagulation in the management of glaucoma after intravitreal silicone oil injection for complicated retinal detachments*. Br J Ophthalmol. 1999 Jun; 83(6): 713–717. doi: 10.1136/bjo.83.6.713.
- Ahmed N, Mahar PS, Rehman AU, et al.: *Efficacy of diode laser in the management of glaucoma following intravitreal silicone oil injection in complicated retinal detachment*. Journal of Ayub Medical College Abbottabad. 2021 Dec; 34: 131–35. <https://doi.org/10.55519/JAMC-01-8981>.
- Sivagnanavel V, Ortiz-Hurtado A, Williamson T: *Diode laser trans-scleral cyclophotocoagulation in the management of glaucoma in patients with long-term intravitreal silicone oil*. Eye. 2005; 19: 253–257. <https://doi.org/10.1038/sj.eye.6701492>.
- Duerr ER, Sayed MS, Moster S, et al.: *Transscleral Diode Laser Cyclophotocoagulation: A Comparison of Slow Coagulation and Standard Coagulation Techniques*. Ophthalmol Glaucoma. 2018 Sep-Oct; 1(2): 115–122. doi: 10.1016/j.ogla.2018.08.007.
- Khodeiry MM, Liu X, Sheheitli H, et al.: *Slow Coagulation Transscleral Cyclophotocoagulation for Postvitrectomy Patients With Silicone Oil-induced Glaucoma*. J Glaucoma. 2021 Sep 1; 30(9): 789–794. doi: 10.1097/IJG.0000000000001893.
- Aquino MC, Barton K, Tan AM, et al.: *Micropulse versus continuous wave transscleral diode cyclophotocoagulation in refractory glaucoma: a randomized exploratory study*. Clin Exp Ophthalmol. 2015 Jan-Feb; 43(1): 40–6. doi: 10.1111/ceo.12360. Epub 2014 Jun 21.
- Zbiba W, Sayadi S, Kharrat M, et al.: *Efficacy and Safety of Micropulse Transscleral Laser Therapy in Silicone Oil-induced Glaucoma*. J Glaucoma. 2022 Aug 1; 31(8): 689–693. doi: 10.1097/IJG.0000000000002051.

Reprint requests to:

Rafał Woś, MD (rafalwos.md@gmail.com)

Prof. K. Gibiński University Clinical Center, Medical University of Silesia in Katowice, Poland

Ceglana 35, 40-514 Katowice, Poland