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Long-term Follow-up of a Case of Gold Shunt Surgery for Refractory Silicone Oil–induced Glaucoma

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Purpose: To report the first case of gold shunt surgery for treatment of silicone oil–induced refractory glaucoma in a tertiary care academic center, with 5-year follow-up.

Design: The study design is a case report.

Participants: The participant was a patient who underwent gold shunt surgery.

Methods: Institutional Research Ethics Board approval for the study was obtained. A diabetic patient was referred for refractory glaucoma with a history of proliferative diabetic retinal detachment, and surgery with silicone oil. She was uncontrolled on maximal medical therapy and following informed consent, gold shunt surgery was performed. Ocular outcomes and number of medications were reviewed over a 5-year period.

Results: Following uncomplicated surgery, intraocular pressure was reduced from 41 to 14 mm Hg, and the number of medications was reduced from 4 to 1. Glaucomatous optic neuropathy remained stable.

Conclusions: Gold shunt surgery in this challenging case of silicone oil refractory glaucoma provided long-term intraocular pressure control and reduced need for medication over a 5-year period.

Key Words: gold shunt, refractory glaucoma, suprachoroidal space, silicone oil, glaucoma surgery

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For patients with advanced glaucoma refractory to maximal medical treatment and laser procedures, a number of possible surgical interventions exist, including trabeculetomy or shunt procedures. Newer devices such as the gold micro shunt (GMS Plus +) have been developed as surgical options for aqueous humor outflow. Gold shunt surgery increases uveoscleral outflow through a natural hydrostatic pressure gradient between the anterior chamber (AC) and the suprachoroidal space. Intraocular pressure (IOP) is controlled without forming an external filtering bleb, a potential source of complications.[1,2] The gold shunt had been approved for use in select European countries since 2005. Health Canada approved its use in treating glaucoma in 2009. In the United States, the gold shunt is in phase III clinical trials to evaluate the device in glaucomatous eyes following failed medical and surgical treatment. Here we report our earliest case of gold shunt surgery, with 5 years follow-up.

CASE REPORT

A 61-year-old Sri Lankan woman and former clerical assistant, was evaluated by the retinal service in December 1999 for a left eye nonresolving vitreous hemorrhage. Her previous ocular history was negative. Her family history was negative for glaucoma. Her past medical history was significant for hypertension, hypothyroidism, and a 15-year history of insulin-dependent diabetes mellitus. Her hypertension was treated with Ramipril 10 mg at hs, Atenolol 100 mg qd, Atacand 16 mg bid, Norvasc 10 mg qd, and Lipitor 40 mg qd and her hypothyroidism was treated with Synthroid 0.05 mg qd.

On examination, visual acuity (VA) was 20/40 OD, hand motion OS, and IOP were 17 mm Hg OU. Anterior segment examination was unremarkable OD and revealed dense posterior subcapsular cataract OS. Fundus examination revealed vitreous hemorrhage OS and ocular ultrasound showed total retinal detachment OS. She underwent left cataract extraction with intraocular lens implantation, pars plana vitrectomy, pan-retinal photocoagulation and silicone oil instillation in February of 2000. Following surgery, VA was counting fingers OS. In December 2002, elevated IOP of 29 mm Hg OS was noted and she was controlled on Cosopt bid. In February 2005, silicone droplets were noted on the iris of her left eye and she was placed on maximal medical therapy for presumed silicone oil–induced secondary glaucoma (Figs. 1A, B). In September 2009, left IOP became uncontrolled and after discussion with the glaucoma service, silicone oil removal was planned. On October 6, 2009, she underwent left silicone oil removal, pars plana vitrectomy, and AC washout. Several months following surgery, left IOP remained uncontrolled.

She was referred to the Glaucoma Unit at St Michael's Hospital on January 26, 2010, where she presented with complaints of pain and redness in the left eye. She was using Alphagan P bid OS, Cosopt 2/0.5% bid OS, and Xalatan 0.005% at hs OS. On examination, best-corrected visual acuity was 20/60-2 OD and 20/200 OS. Ocular motility was full and pupils were minimally reactive to light. IOPs were 18 and 41 mm Hg in the right and the left eyes, respectively. Corneal thicknesses were 555 and 566 μm in the right and left eyes, respectively. Slit-lamp examination revealed wide open angles, and cup to disc ratios of 0.6 and 0.9 in the right and the left eyes, respectively. No neovascular changes were seen on the iris. Left posterior chamber intraocular lens was in good position and emulsified droplets were seen in the anterior segment, on iris and trabecular meshwork.

The options of trabeculectomy or approved shunt procedures including the recently approved in Canada gold shunt were discussed. The benefits and risks were discussed in detail, including the

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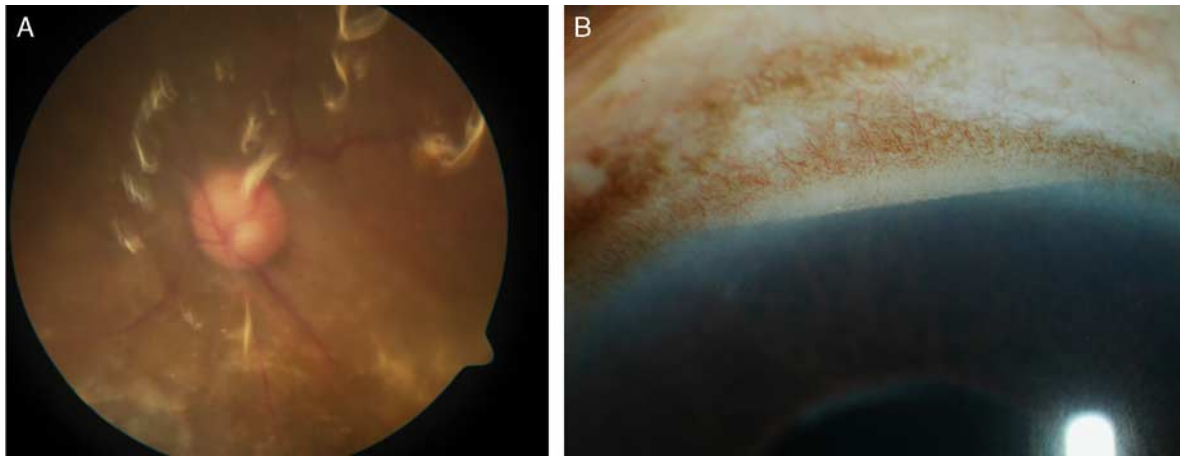

FIGURE 1. A, Left eye fundus view through silicone oil. B, Anterior segment shows inverted emulsified silicone oil level.

risk of complete sight loss and that she would be our first patient to receive a gold shunt. She elected to proceed with the latter and after informed consent, she underwent left uncomplicated gold shunt surgery on February 2, 2010.

Under topical anesthesia, and subconjunctival lidocaine with epinephrine, a fornix-based conjunctival flap was dissected and episcleral vessels were cauterized. A 67 blade was used to dissect a full thickness scleral incision posteriorly to expose the choroid and the AC was entered with a scleral tunnel. The anterior portion of the gold shunt (GMS Plus +) was placed in the AC, and the posterior aspect was placed into the suprachoroidal space. During positioning, the gold shunt floated into the AC and was retrieved with a Sinskey hook. The shunt was positioned so that approximately 1.5 mm was visible in the AC. The sclera was tightly closed with two 10-0 nylon sutures and the conjunctiva with two 9-0 vicryl sutures.

On examination the same day, the left eye was comfortable, uncorrected VA was counting fingers at 6 inches OS, and IOP measured 6 mm Hg OS. Trace inflammation was noted in the AC. She was treated with Ocuflox qid and Pred Forte 1% qh for 3 weeks. During this time, VA improved to 20/200 OS and IOP ranged from 5 to 14 mm Hg OS. At 6 weeks, IOP measured 15 mm Hg OS, gold shunt was in good position in the presence of advanced glaucomatous optic neuropathy (Figs. 2A, B).

During her first year of follow-up, she was evaluated at approximately 2 month intervals and IOP ranged from 10 to 15 mm Hg OS. On December 7, 2011, left IOP was noted to be 25 mm Hg and she was started on timolol 0.5% qd increased to bid use with IOP controlled in the midteens. At her last visit on June 17, 2015, VA remained counting fingers at 2 ft OS, IOP measured 14 mm Hg OS at 1210. Glaucomatous optic neuropathy remained stable and gold shunt was in good position (Figs. 3A, B).

DISCUSSION

Gold shunt surgery in this challenging patient effectively reduced IOP and the number of medications required over a 5-year period. IOP was reduced by 65.9% and the number of medications reduced by 75%. Previous studies have reported gold shunt success rates ranging from 67.3% to 79% in treating refractory glaucoma.[3,4] Another study found that over a period of 5 years, gold shunts and Ahmed valves had similar efficacy.[5] Five-year follow-up of gold shunt surgery has been infrequently reported in the literature. In the largest prospective study of 20 patients, only 8 patients with gold shunt reached 5-year follow-up with 72% success rate. However, all patients with a history of surgery for ocular disease other than glaucoma, were excluded.[5] In

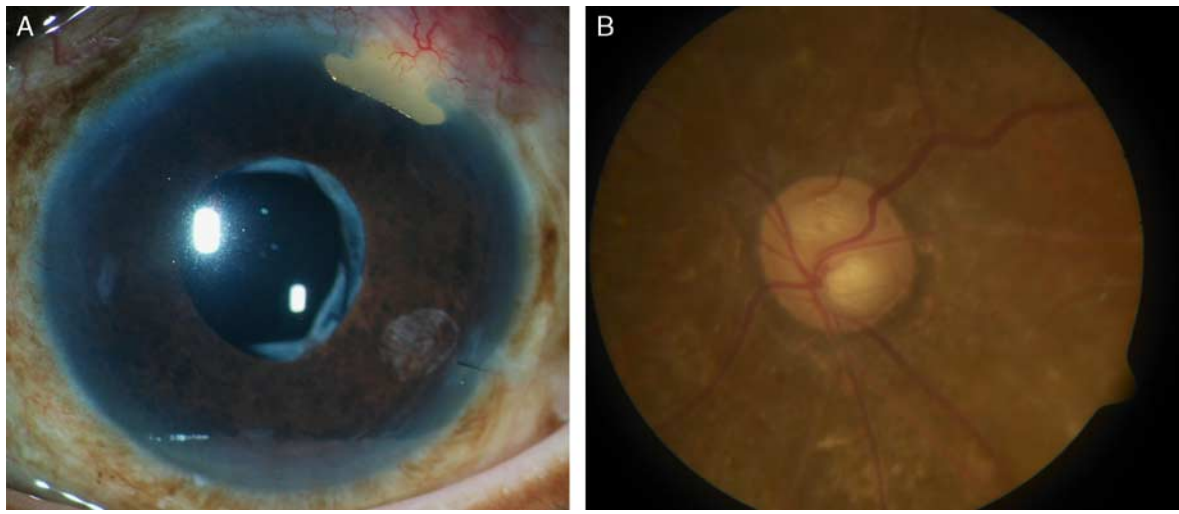

FIGURE 2. A, Left eye anterior segment with gold shunt in the superotemporal quadrant 6 weeks after surgery. B, Advanced glaucomatous optic neuropathy.

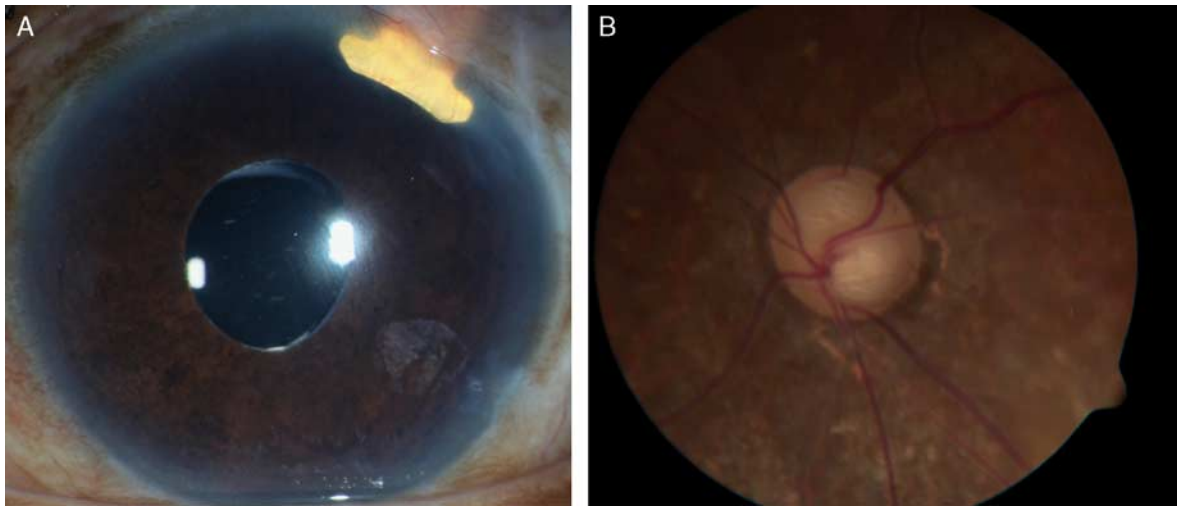

FIGURE 3. A, Left eye anterior segment with gold shunt 5 years after surgery. B, Advanced glaucomatous optic neuropathy appears stable.

another, only 1 of 31 cases reached 46 months follow-up, and was reported as successful.[6] We recently reported well-controlled glaucoma 5 years after gold shunt surgery in a unique case of advanced low-tension glaucoma with spared central acuity, refractory to other filtering procedures.[7] This case would have been excluded from entry into the other studies based on IOP and central acuity inclusion criteria. This case of silicone oil–induced glaucoma reported here would not have been eligible for the gold shunt in other studies, due to exclusion of patients with nonglaucoma disease and history of nonglaucoma surgery.

Past reports of shunt ineffectiveness with failure occurring early within the first 2 years, used different surgical techniques and an earlier model of the gold shunt.[6,8] The generation 3 model (GMS Plus +) used in this case was approved for use by Health Canada in 2009. Previous generation 1 (GMS) and generation 2 (GMS Plus) models had lower flow rate, and did not come preloaded. Although the technical details of differences between devices are not readily accessible, the new generation 3 model is designed to allow fluid flow to no longer be restricted to discrete channels. The main reason for shunt failure appears to be fibrosis, causing encapsulation of the device and impeding flow.[9,10] An increased profibrosis cytokine environment in the aqueous humor of glaucoma patients may increase predisposition to shunt failure.[11]

Silicone oil is a synthetic polymer that is commonly used to provide internal tamponade for surgical treatment of severe diabetic retinal detachments. Known complications from silicone oil use include AC oil emulsification and glaucoma.[12] Silicone oil is associated with open-angle glaucoma and angle-closure glaucoma through different mechanisms. Our patient upon initial examination had wide open angles with retained emulsified droplets of oil on the iris and trabecular meshwork postoil removal. There are a variety of treatments available for silicone oil–induced glaucoma including trans-scleral cyclophotocoagulation, trabeculectomy, drainage devices, and oil removal.[13] Studies have shown trans-scleral cyclophotocoagulation success rates to be highly variable, ranging from 44% to 82%.[14,15] Trabeculectomy has a limited role in treating silicone oil–induced glaucoma because of prior scarring from vitreo-retinal surgery making the procedure difficult to perform.[12,13] Drainage devices such as Ahmed valves have shown better success rates with 86% at 6 months postoperation and 76% at 1 year.[16] Silicone oil removal had a reported success rate of 93.4% by Jonas et al[17] Budenz et al[18] reported 69% success rate with oil removal at 6 months postsurgery and 48% at 3 years. For patients that retained droplets of silicone oil postoil removal, approximately 74% required surgical treatment, specifically AC washout.[19]

In our case, both silicone oil and AC washout were performed, but the glaucoma remained uncontrolled. One possible mechanism of open-angle silicone oil–induced glaucoma is infiltration of microdroplets into the trabecular meshwork causing inflammation and impeding aqueous outflow.[12] This patient with challenging glaucoma continues to be well controlled 5 years following gold shunt surgery. This is a single case of a uniquely complex patient with retinal disease that would not typically be considered for gold shunt surgery based on gold shunt studies to date. Further long-term studies on gold shunt efficacy and safety are needed.

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REFERENCES

1. Francis BA, Singh K, Lin SC, et al. Novel glaucoma procedures: a report by the American Academy of Ophthalmology. *Ophthalmology*. 2011;118:1466–1480.
2. Emi K, Pederson JE, Toris CB. Hydrostatic pressure of the suprachoroidal space. *Invest Ophthalmol Vis Sci*. 1989;30:233–238.
3. Melamed S, Ben Simon GJ, Goldenfeld M, et al. Efficacy and safety of gold microshunt implantation to the supraciliary space in patients with glaucoma: a pilot study. *Arch Ophthalmol*. 2009;127:264–269.
4. Figus M, Lazzeri S, Fogagnolo P, et al. Supraciliary shunt in refractory glaucoma. *Br J Ophthalmol*. 2011;95:1537–1541.
5. Skaat A, Sagiv O, Kinori M, et al. Gold micro-shunt implant versus Ahmed glaucoma valve: long-term outcomes of a prospective randomized clinical trial. *J Glaucoma*. 2016;25:155–161.

6. Hueber A, Roters S, Jordan JF, et al. Retrospective analysis of the success and safety of Gold Micro Shunt Implantation in glaucoma. *BMC Ophthalmol*. 2013;13:35–40.
7. Le R, Gupta N. Gold shunt for refractory advanced low tension glaucoma with spared central acuity. *Int Med Case Rep J*. 2016;9:69–72.
8. Rekas M, Pawlik B, Grala B, et al. Clinical and morphological evaluation of gold micro shunt after unsuccessful surgical treatment of patients with primary open-angle glaucoma. *Eye (Lond)*. 2013;27:1214–1217.
9. Agnifili L, Costagliola C, Figus M, et al. Histological findings of failed gold micro shunts in primary open-angle glaucoma. *Graefes Arch Clin Exp Ophthalmol*. 2012;250:143–149.
10. Berk TA, Tam DY, Werner L, et al. Electron microscopic evaluation of a gold glaucoma micro shunt after explantation. *J Cataract Refract Surg*. 2015;41:674–680.
11. Tripathi RC, Li J, Chan WF, et al. Aqueous humour in glaucomatous eyes contains an increased level of TGF-beta 2. *Exp Eye Res*. 1994;59:723–727.
12. Miller JB, Papakostas TD, Vavvas DG. Complications of emulsified silicone oil after retinal detachment repair. *Semin Ophthalmol*. 2014;29:312–318.
13. Ichhpujani P, Jindal A, Jay Katz L. Silicone oil induced glaucoma: a review. *Graefes Arch Clin Exp Ophthalmol*. 2009; 247:1585–1593.
14. Han SK, Park KH, Kim DM, et al. Effect of diode laser transscleral cyclophotocoagulation in the management of glaucoma after intravitreal silicone oil injection for complicated retinal detachments. *Br J Ophthalmol*. 1999;83:713–717.
15. Sivagnanavel V, Ortiz-Hurtado A, Williamson TH. Diode laser trans-scleral cyclophotocoagulation in the management of glaucoma in patients with long-term intravitreal silicone oil. *Eye (Lond)*. 2005;19:253–257.
16. Al-Jazzaf AM, Netland PA, Charles S. Incidence and management of elevated intraocular pressure after silicone oil injection. *J Glaucoma*. 2005;14:40–46.
17. Jonas JB, Knorr HL, Rank RM, et al. Intraocular pressure and silicone oil endotamponade. *J Glaucoma*. 2001;10:102–108.
18. 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;108:1628–1632.
19. Lin XF, Liang LY, Lin MK, et al. Treatment of glaucoma secondary to silicone oil retention. *Retina*. 2005;25:515–517.