• Clinical Research •

Retrolaminar migration as a complication of intraocular silicone oil injection detected on unenhanced CT

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Abstract

● **AIM:** To describe the clinical and radiologic features of retrolaminar migration silicone oil (SiO) and observe the dynamic position of ventricular oil accumulation in supine and prone.

● **METHODS:** For this retrospective study, 29 patients who had a history of SiO injection treatment and underwent unenhanced head computed tomography (CT) were included from January 2019 to October 2022. The patients were divided into migration-positive and negative groups. Clinical history and CT features were compared using Whitney *U* and Fisher's exact tests. The dynamic position of SiO was observed within the ventricular system in supine and prone. CT images were visually assessed for SiO migration along the retrolaminar involving pathways for vision (optic nerve, chiasm, and tract) and ventricular system.

● **RESULTS:** Intraocular SiO migration was found in 5 of the 29 patients (17.24%), with SiO at the optic nerve head (*n*=1), optic nerve (*n*=4), optic chiasm (*n*=1), optic tract (*n*=1), and within lateral ventricles (*n*=1). The time interval between SiO injection and CT examination of migration-positive cases was significantly higher than that of migration-negative patients (22.8±16.5mo *vs* 13.1±2.6mo, *P*<0.001). The hyperdense lesion located in the frontal horns of the right lateral ventricle migrated to the fourth ventricle when changing the position from supine to prone.

● **CONCLUSION:** Although SiO retrolaminar migration is unusual, the clinician and radiologist should be aware of migration routes. The supine combined with prone examination is the first-choice method to confirm the presence of SiO in the ventricular system.

● **KEYWORDS:** retrolaminar migration; silicone oil tamponade; unenhanced head computed tomography; supine and prone computed tomography

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INTRODUCTION

Vitrectomy has been the second most common operation in ophthalmology, including acute and elective indications[1]. The annual incidence rate of extensive population-based retinal detachment studies is about 1/10.000[2]. Due to its high surface tension, silicone oil (SiO) has been used as a filler to treat complex retinal detachments[3-4]. Cibis *et al*[5] first introduced intravitreal SiO injection as an implant in 1962. Although SiO is considered relatively safe, its diffusion into adjacent structures through the vitreous cavity by prolonged intraocular duration may lead to known complications, such as glaucoma, cataracts, and keratopathy formation[6].

Retrolaminar migration becomes a complication unknown to some ophthalmologists because intraocular SiO is emulsified into silicone droplets in the vitreous to some extent[7]. Some radiologists must be aware of the typical locations of SiO migration on computed tomography (CT)[8]. The SiO diffuses posteriorly and migrates into the retina and the pathways for vision (optic nerve, chiasm, and tract), and even its

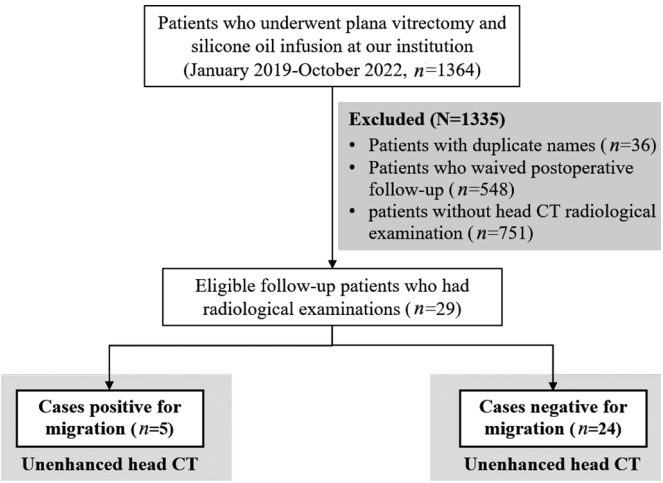

Figure 1 Flow diagram of the process used to select subjects for this study CT: Computed tomography.

progression into the subarachnoidal and ventricular system[9-11]. One published study attempted to report the incidence of retrolaminar migration of SiO and present radiologic findings and clinical features based on unenhanced CT scans of the head[12]. However, the study was limited by confirmation of migration of SiO into the lateral ventricular, and characteristic clinical indicators were relatively insufficient.

This study aimed to describe the clinical, ophthalmic, and radiologic features of retrolaminar migration SiO and observe the dynamic position of ventricular oil accumulation in the supine and prone positions.

SUBJECTS AND METHODS

Ethical Approval The Ethics Committee of Ophthalmology Department of Zhejiang Provincial People's Hospital review board approved this retrospective study (No.2022QT385) and waived the requirement for written informed consent. The relevant guidelines and regulations were performed in this study.

Study Sample From January 2019 to October 2022, a total of 1364 patients underwent SiO infusion following vitrectomy at Ophthalmology Department of Zhejiang Provincial People's Hospital was collected. Some cases were excluded from this study to ensure observation of intraocular SiO status in discharged patients. The exclusion criteria are as follows: patients with duplicate names (n=36), patients who waived postoperative follow-up (n=548), and patients without head CT radiological examination (n=751). Finally, twenty-nine follow-up patients who had unenhanced head CT examinations were included and divided into cases of positive and negative for migration, respectively (Figure 1).

Some patient's clinical demographics information was recorded in the electronic medical records, such as relevant clinical history, indications of SiO injection treatment and CT examinations, the time-interval between SiO injection and CT examination, volume of SiO injection, ophthalmic examination visual acuity, and intraocular pressure (IOP).

Computed Tomography Examination Unenhanced CT scans of the head were performed at 5-mm section thickness and interval using two CT scanners as follows: 1) SOMATOM Definition AS+ (Siemens Medical Systems, Erlangen, Germany); 2) Aquilion ONE (Toshiba Medical Systems, Tokyo, Japan). The head was scanned with all patients in a supine position, except a patient who was in prone position at the second examination. Scanner settings of 100–120 kilovolt peak, 512×512 matrix, and automatic tube current were used. CT data were reconstructed at 1-mm section thickness and interval with brain algorithm reconstruction.

Imaging Analysis All CT images were used to visually assess for migration of SiO, including the pathways for vision (optic nerve, chiasm, and tract) and the ventricular system.

Retrolaminar migration of SiO was evaluated by a clinical ophthalmologist (Wu YY, with 11y of work experience) and two radiologists (Zhao FF and Pan YL, with 4 and 15y of work experience, respectively) independently completed the review of the CT images, any discrepancy among the three doctors was solved during a multi-disciplinary team conference, where a decision was determined by consulting with a third board-certified radiologist (Gong XY, with 35y of head and neck radiology work experience).

Statistical Analysis The data were analyzed using SPSS, Version 26.0 (IBM Corp., Armonk, NY, USA). Clinical information, ophthalmic manifestations, and CT features were compared to migration-positive and negative cases. Sex was compared using Fisher's exact test and the Mann-Whitney U test for continuous variables (age, the interval time between SiO injection and CT examination, volume of SiO injection, and IOP). All values for variables are expressed as mean±standard deviation. A P value of <0.05 was considered statistically significant.

RESULTS

Study Population Among 29 patients who had a history of SiO injection treatment and underwent unenhanced head CT examination were analyzed. The numbers of men and women were 20 (69.0%) and 9 (31.0%), respectively. The mean age of the entire study population was 54.7±12.8y (range, 29–85y). Twelve patients were in therapy with SiO injection on the left side and fifteen patients on the right side; two patients were injected with SiO on both sides.

Comparison of Clinical Information Between Positive and Negative Patients for Migration Age and sex were not significantly different between migration-positive and negative cases (P=0.382, 0.287, respectively). There was no statistically significant difference in the volume of SiO injection between migration-positive and negative cases (5.0±1.6 *vs* 5.2±1.2 mL, P=0.482). However, the time-interval between SiO injection

Figure 2 Axial non-contrast head CT scan with cases 2 and 5 in the supine position A nodular hyperdense SiO lesion in the left optic nerve head (A) and ipsilateral optic nerve (B), respectively. SiO: Silicone oil; CT: Computed tomography.

Figure 3 Migration of post-laminar SiO into the optic nerve, optic chiasm, tract, and lateral ventricles (case 4) A: Axial in the supine position unenhanced CT shows increased tubular density in the left infraorbital segment of the right optic nerve; B: A nodular hyperdense in the right anterior aspect of the suprasellar cistern; C: Bilateral hyperdense bodies in the frontal horns of the lateral ventricles. SiO: Silicone oil; CT: Computed tomography.

Figure 4 After 30d, axial non-contrast head CT scan with case 4 in the prone position Hyperdense bodies previously in the right anterior horns of the lateral ventricles (A) have moved dorsally to the fourth ventricle (B and C). CT: Computed tomography.

and CT examination of migration-positive cases was significantly higher than that of migration-negative cases (22.8±16.5 *vs* 13.1±2.6mo, $P<0.001$). Retrolaminar migration of SiO was observed as early as nine months and as late as approximately 4y later after SiO injection. IOP evaluation had been recorded in two patients, and one patient waived this examination. IOP on the treatment side of SiO injection was not significantly different among migration-positive ($n=4$) and negative ($n=24$) cases (19.6±5.4 *vs* 15.9±4.6 mm Hg, $P=0.162$). The clinical characteristics of migration-positive and negative cases are presented in Table 1.

Radiologic and Clinical Characteristics of Retrolaminar Silicone Oil Migration The radiologic and clinical characteristics of retrolaminar migration cases are shown in Table 2. Retrolaminar SiO migration was found in 5 of the 29 patients (17.24%; 3 men and 2 women; mean age, 50y; range, 36-85). Four patients to one area (optic nerve or optic nerve head), and one patient to four areas each (optic nerve, chiasm, tract, and ventricular system), with SiO at the optic nerve head ($n=1$), retrolaminar optic nerve ($n=4$), optic chiasm ($n=1$), optic tract ($n=1$), and within lateral ventricles ($n=1$). Some cases of SiO migration based on the axial head CT are presented in Figure 2. For case 4, an unenhanced head CT scan of the patient was performed in the supine position, demonstrating two hyperdense SiO within the frontal horns of the lateral ventricles bilaterally (Figure 3). After 30d, a CT head scan was again performed using the same device with the patient in the prone position; the previous hyperdense SiO located in the frontal horns of the right lateral ventricles migrated to the fourth ventricle (Figure 4).

Table 1 Comparisons of clinical features of cases between positive and negative for SiO migration mean±SD

Clinical characteristics	Cases positive for migration (*n*=5)	Cases negative for migration (*n*=24)	*P*	Total (*n*=29)
Age (y)	51.2±20.8	55.4±11.0	0.382[a]	54.7±12.8
Sex (male/female)	2:3	18:6	0.287[b]	20:9
Indication for SiO injection treatment	Diabetic retinal detachment: 3; Terson syndrome: 1; trauma: 1	Diabetic retinal detachment: 17; Terson syndrome: 2; trauma: 3; morning glory syndrome: 2		Diabetic retinal detachment: 20; Terson syndrome: 3; trauma: 4; morning glory syndrome: 2
Interval between silicone injection treatment and CT examination (mo)	22.8±16.5	13.1±2.6	0.001[a]	16.3±5.8
Volume of silicone injection (mL)	5.0±1.6	5.2±1.2	0.482[a]	5.2±1.3
IOP (mm Hg)	19.6±5.4	15.9±4.6	0.162[a]	16.5±4.9

SiO: Silicone oil; CT: Computed tomography; IOP: Intraocular pressure. [a]Mann-Whitney *U* test; [b]Fisher exact test.

Table 2 Case series of posterior migration patients with basic ophthalmic, and radiologic characteristics

Case No.	Sex/age (y)	Indication for SiO	Indication for CT	Interval between silicone injection and CT (mo)	Visual acuity	IOP (mm Hg)	Volume of silicone injection (mL)	Side of silicone injection	Location of silicone migration
1	Female/36	Diabetic retinal detachment	Headache	9	Left eye CF	19	6.5	Left	Retrolaminar optic nerve
2	Female/37	Trauma	Trauma	36	Left eye 80/400	21	3.5	Left	Optic nerve head
3	Female/40	Terson syndrome	Trauma	10	Left eye 48/400	17	4.2	Right	Retrolaminar optic nerve
4	Male/58	Diabetic retinal detachment	Cerebral infarction	45	Right eye NLP	28	Unknown	Right	Retrolaminar optic nerve, optic chiasm, optic tract, and lateral ventricles
5	Male/85	Diabetic retinal detachment	Ataxia, headache	14	Left eye poor vision, exact acuity unknown	Unknown	4.0	Left	Retrolaminar optic nerve

SiO: Silicone oil; CT: Computed tomography; IOP: Intraocular pressure; NLP: No light perception; CF: Counting fingers.

DISCUSSION

Intraocular SiO injection has been widely used to treat complex retinal detachments[3]. SiO is chemically inert, which is relatively safe and effective for intraocular use in vitreoretinal surgery[13]. According to the literature, intracerebral migration of SiO may occur between 2mo and 12y after the initial intraocular tamponade[3,14]. It is unclear clinically whether SiO that has diffused to the extraocular region should be addressed surgically, and the patients are generally asymptomatic[15]. Most patients have intraocular SiO taken out 3-6mo after filling, and periodic CT examination is not widely accepted during and after this period[16]. Specifically, the majority of SiO are found incidentally, and they are relatively fixed in unstinted locations. This phenomenon was initially proposed by Ni[17] in 1983 and was called retrolaminar migration of intraocular SiO. There are few kinds of literature have studied the correlation between retrolaminar SiO migration and clinical features[18-19]. In this study, we compared the correlation of retrolaminar migration features with clinical information on unenhanced CT images, summarized the characteristics of clinically negative and positive patients for migration. Meanwhile, we observed follow-up case dynamic migration radiological features. Migration was detected in 17% of patients, equivalent to the histopathological study (11%-24%) after removing eyeballs with SiO injection[20].

Subretinal SiO migration posteriorly is considered a benign phenomenon commonly detected in the cross-sectional image[9]. In our series, there was one positive case with significant neuro-ophthalmologic and severe headaches associated with SiO migration documented in the electronic medical records. In this case, this visual symptom has been reported to be related to SiO direct infiltration of tissue leading to optic nerve damage, bipolar cells in the outer plexiform layer, and loss of photoreceptor synaptic terminals[21-22]. The mechanism of this patient's severe headaches is not precise. A possible reason is that the cerebrospinal fluid pathway is obstructed by the SiO globules and temporarily increases intracranial pressure[23]. The third or fourth ventricle is most likely to be this symptomatic compared to the lateral ventricles[4,24-25].

Shields[26] proposed in 1989 that high IOP indirectly affected SiO migration. But not all cases are associated with previously existing IOP[27]. Although the IOP at one side of patients with migration-positive of SiO injection was slightly higher than that of patients with negative migration in this study, it was not a statistically significant difference. In addition, we found that the time-interval between SiO injection and CT examination showed a significant difference between migration-positive and negative cases. However, Abdelkader *et al*[12] reported no statistically significant difference in interval time. The differences in our findings and theirs may be caused by ethnic differences in the eye's anatomical configurations and indicate a potential influence of ethnicity on internal structure. Meanwhile, the volume of SiO injection shows no statistically significant between migrate-positive and negative cases.

The exact migration mechanism of intraocular SiO into the cerebral ventricles remains controversial. A recent study shows that SiO may permeate directly into the retina layers and then enter the optic nerve *via* lamina cribrosa[28]. In cases of high IOP, SiO can enter the optic nerve subarachnoid space at some locations by penetrating the cerebral soft meninges[27]. Since there is a connection between the optic nerve subarachnoid space and intracranial subarachnoid space, SiO can make entry into the ventricular system via the third ventricle foramina[9]. Jabbour *et al*[29] proposed a different mechanism from ventricular migration, with silicone migrating through the optic nerve, chiasm, and tract to the thalamus and possibly migrating into the lateral ventricles through the choroidal fissure.

The present study has several limitations that must be considered. First, this study's prevalence was reduced in statistical power and accuracy because of its retrospective design and the small number of patients. Second, we excluded patients by searching for keywords in the electronic medical record, which may have introduced a selection bias. Third, retrolaminar migration of the SiO was evaluated according to the specialists' experience, which may have potentially caused a promising result. Fourth, detailed clinical ophthalmic examinations, including IOP and SiO injection volume, are unavailable in all cases and lack histopathologic confirmation.

In summary, retrolaminar migration of SiO is relatively rare and often without clinical symptoms. Radiologist need to pay attention to the occurrence of this complication and familiarize themselves with its radiographic features and migration patterns to prevent misdiagnosis of ventricular hemorrhage. Supine combined with prone examination is the first-choice method to confirm the presence of SiO in the ventricular system.

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REFERENCES

1 Pichi F, Hay S, Abboud EB. Inner retinal toxicity due to silicone oil: a case series and review of the literature. *Int Ophthalmol* 2020;40(9):2413-2422.

2 Coman Cernat CC, Munteanu M, Malita D, Stanca S, Patoni Popescu SI, Musat O, Negru S, Feier H, Karancsi OL, Rosca C. Corneal endothelial changes induced by pars Plana vitrectomy with silicone oil tamponade for retinal detachment. *Exp Ther Med* 2021;22(3):961.

3 Grzybowski A, Pieczynski J, Ascaso FJ. Neuronal complications of intravitreal silicone oil: an updated review. *Acta Ophthalmol* 2014;92(3):201-204.

4 Wang YF, Huang ZJ, Zheng D, Liu JT, Huang DG, Zheng JL, Xie HN, Lin P, Chen WQ. Adequate silicone oil tamponade by utilizing the space of anterior segment for complicated retinal detachment: technique, efficacy, and safety. *Asia Pac J Ophthalmol (Phila Pa)* 2021;10:564-571.

5 Cibis PA, Becker B, Okun E, Canaan S. The use of liquid silicone in retinal detachment surgery. *Arch Ophthalmol* 1962;68(5):590-599.

6 Abu-Yaghi NE, Abu Gharbieh YA, Al-Amer AM, AlRyalat SAS, Nawaiseh MB, Darweesh MJ, Alkukhun LR, Abed AM, Saleh OA, Ababneh OH. Characteristics, fates and complications of long-term silicone oil tamponade after pars plana vitrectomy. *BMC Ophthalmol* 2020;20(1):336.

7 Shiihara H, Terasaki H, Yoshihara N, Shirasawa M, Otsuka H, Yamashita T, Yamakiri K, Sonoda S, Sakamoto T. Amount of residual silicone oil in vitreous cavity is significantly correlated with axial length. *Retina* 2016;36(1):181-187.

8 Carneiro F, Vaz ND. Prone CT for diagnosis of silicone oil intraventricular migration after intraocular tamponade. *Radiol Case Rep* 2019;14(7):864-867.

9 Boren RA, Cloy CD, Gupta AS, Dewan VN, Hogan RN. Retrolaminar migration of intraocular silicone oil. *J Neuro Ophthalmol* 2016;36(4):439-447.

10 Filippidis AS, Conroy TJ, Maragkos GA, Holsapple JW, Davies KG. Intraocular silicone oil migration into the ventricles resembling intraventricular hemorrhage: case report and review of the literature. *World Neurosurg* 2017;102:695.e7-695695.e10.

11 Sharifi M, Ansari Astaneh M. Migration of silicone oil into the orbit and eyelid as a cyst. *Case Rep Ophthalmol* 2020;11(2):217-221.

12 Abdalkader M, Takumi K, Chapman MN, Barest GD, Peeler C, Sakai O. Subretinal and retrolaminar migration of intraocular silicone oil detected on CT. *Am J Neuroradiol* 2019;40(9):1557-1561.

13 Rhatigan M, McElnea E, Murtagh P, Stephenson K, Harris E, Connell P, Keegan D. Final anatomic and visual outcomes appear independent of duration of silicone oil intraocular tamponade in complex retinal detachment surgery. *Int J Ophthalmol* 2018;11(1):83-88.

14 Mathis S, Boissonnot M, Tasu JP, Simonet C, Ciron J, Neau JP. Intraventricular silicone oil: a case report. *Medicine* 2016;95(1):e2359.

15 Cao JT, Bian LL, Zhou PP, Tu JC. Watch out for the special location of intraventricular silicone oil following an intraocular tamponade - a 10-year follow-up case report based on CT/MRI. *BMC Ophthalmol* 2019;19(1):269.

16 Cao SG, Zhao H, Wang J, He J, Xia MW, Xu WA. Moving silicone oil particles in the ventricle: a case report and updated review. *BMC Ophthalmol* 2022;22(1):96.

17 Ni C. Intravitreous silicone injection. *Arch Ophthalmol* 1983;101(9):1399.

18 Knecht P, Groscurth P, Ziegler U, Laeng HR, Jaggi GP, Killer HE. Is silicone oil optic neuropathy caused by high intraocular pressure alone? A semi-biological model. *Br J Ophthalmol* 2007; 91(10):1293-1295.

19 Lam SC, Chan AYY, Yuen HKL. Extraocular silicone oil migration to orbit and retrolaminar region: case report and systematic review. *Graefes Arch Clin Exp Ophthalmol* 2020;258(12):2799-2807.

20 Biswas J, Verma A, Davda M, Ahuja S, Pushparaj V. Intraocular tissue migration of silicone oil after silicone oil tamponade: a histopathological study of enucleated silicone oil-filled eyes. *Indian J Ophthalmol* 2008;56(5):425.

21 Lo DM, Flaxel CJ, Fawzi AA. Macular effects of silicone oil tamponade: optical coherence tomography findings during and after silicone oil removal. *Curr Eye Res* 2017;42(1):98-103.

22 Christensen UC, la Cour M. Visual loss after use of intraocular silicone oil associated with thinning of inner retinal layers. *Acta Ophthalmol* 2012;90(8):733-737.

23 Ferrara M, Coco G, Sorrentino T, Jasani KM, Moussa G, Morescalchi F, Dhawahir-Scala F, Semeraro F, Steel DHW, Romano V, Romano MR. Retinal and corneal changes associated with intraocular silicone oil tamponade. *J Clin Med* 2022;11(17):5234.

24 Potts MB, Wu AC, Rusinak DJ, Kesavabhotla K, Jahromi BS. Seeing floaters: a case report and literature review of intraventricular migration of silicone oil tamponade material for retinal detachment. *World Neurosurg* 2018;115:201-205.

25 Cao JL, Browne AW, Clifford T, Sharma S, Patel V. Intravitreal silicone oil migration into the lateral cerebral ventricles. *J Vitreoretin Dis* 2019;3(6):466-473.

26 Shields CL. Pseudo-schnabel's cavernous degeneration of the optic nerve secondary to intraocular silicone oil. *Arch Ophthalmol* 1989;107(5):714.

27 Papp A, Tóth J, Kerényi T, Jäckel M, Süveges I. Silicone oil in the subarachnoidal space—a possible route to the brain? *Pathol Res Pract* 2004;200(3):247-252.

28 Wang Y, Ryu CL, Mokhtarzadeh A, Lee M, Harrison A, McClelland C. Optic nerve sheath fenestration for treatment of retrolaminar silicone oil migration. *Ophthalmic Plast Reconstr Surg* 2019;35(2):e31-e34.

29 Jabbour P, Hanna A, Rosenwasser R. Migration of silicone oil in the cerebral intraventricular system. *Neurol* 2011;17(2):109-110.