Diagnostic and Therapeutic Challenges

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Case Report

We present a 53-year-old woman with cataract, traction retinal detachment in association with full-thickness retinal holes at the nasal arcades, and vitreous hemorrhage. Visual acuity was hand movement (HM) in the right eye. We performed a routine 20G vitrectomy and phacoemulsification with silicone oil tamponade, without intraocular lens implantation. These eyes had been given a ranibizumab intravitreal injection 5 days before surgery. On the first day after surgery, we found there were a multitude of bubbles mixed with the silicone oil. The fundus was blurred with a light anterior chamber inflammatory reaction and a small amount of hyphema (Figure 1, A and B). The small vesicles faded away 4 days later, and the fundus becomes visible (Figure 1C). The silicone oil was replaced 6 weeks later because of silicone oil emulsion and recurrent nasal retinal detachment. The fundus and the new silicone oil were stable until the 6-month follow-up (Figure 1D). This phenomenon of innumerable small “bubbles” in the silicone oil did not occur with the same batch of silicone oil used at a later time.

This case is presented for discussion of the possible causes of the “bubbles” within the silicone oil, which disappeared within several days of surgery. We would ask for your thoughts on whether the premature oil emulsification might be related to these postoperative bubbles.

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Dr. Yannek I. Leiderman (Chicago, Illinois):

The authors present a surgical case of a 53-year-old woman with combined tractional and rhegmatogenous retinal detachment, and vitreous hemorrhage. Surgical intervention consisted of 20-gauge pars plana vitrectomy, lensectomy through phacoemulsification, and silicone oil endotamponade. Biomicroscopy on the first postoperative day revealed hyphema, anterior chamber inflammation, and numerous bubbles within the silicone oil endotamponade. The immiscible bubbles resolved over four days; however, there was progressive emulsification of the silicone oil. Recurrent retinal detachment prompted repeat vitrectomy surgery at 6 weeks, at which time the silicone oil was replaced with a new aliquot sourced from the same batch used in the initial surgery. The patient made an uneventful recovery, and the silicone oil tamponade remained uniform during the subsequent 6 months. The authors inquire as to the etiology of the inhomogeneities noted early in the postoperative course, and if these were possibly associated with the subsequent silicone oil emulsification.

Silicone oil is used for long-term or permanent tamponade, most commonly in cases of complex retinal detachment. In the United States, medical-grade polydimethylsiloxane is used in vitreoretinal surgery, and commercially available viscosities include 1,000 and 5,000 centistokes. Other formulations of silicone oil have been used in other countries, ranging from 1,000 to 10,000 centistokes, and hydroxyl-enriched polydimethylsiloxane and trimethylsiloxy-terminated polydiphenylsiloxane have been used.¹ Silicone oil is slightly less dense than vitreous fluid, causing oil to float to the highest point in the vitreous cavity.

An emulsion is a system consisting of two liquid phases, and a silicone oil emulsion in the eye is generally incomplete, with emulsification beginning

Fig. 1. On the first day after surgery follow-up: (A) the anterior chamber reaction was light with a small amount of hyphema. B. There were multiple vesicles mixed with the silicone oil. C. With the vesicles' absorption, the fundus was visible 4 days later. D. The fundus and the exchanged new silicone oil were stable till the 6-month follow-up.

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at the interface of two liquid phases,¹ generally at the retinal surface or an interface with liquid vitreous or anterior chamber fluid. Emulsification requires the application of mechanical energy to the system, and surface-active agents must be present for stabilization. Mechanical energy is introduced through eye movement,² and possibly vigorous movements of the head and body. Biological emulsifiers may be present in vitreous and aqueous fluids and vary under different pathologic conditions.¹ Fibrinogen, fibrin, and serum, as present in intraocular blood, are among the most potent biologically occurring agents in promoting emulsification.¹⁻³ Low-molecular weight formulations of silicone oil are more prone to emulsification, and in vitro experimental evidence suggests that early formulations of low-molecular weight (1,000 centistoke) silicone oil may have been more prone to emulsification compared with more viscous formulations.¹⁻⁴

Of note, experimental studies of early silicone oil formulations suggested that a complete oil fill is

protective against emulsification in contrast to silicone oil admixed with liquid vitreous.⁵ Investigations of contemporary formulations of silicone oil failed to reveal a differential rate of emulsification among 500, 1,000, and 5,000 centistoke silicone oils.⁶ Emulsification is not observed in the immediate postoperative period given the need for the application of mechanical energy in a permissive environment, and the time-course to clinically evident emulsification is generally one month or longer.⁷

Opacification of silicone oil is a reduction in the optical clarity of silicone oil associated with contamination of silicone oil with solvents, detergents, or other exogenous agents and may result in phase separation of the mixture.⁸ In contrast to emulsification, opacification may be observed immediately or soon after contact with an inciting agent. Phase separation may have accounted for the authors' observation of vesicular bodies within the oil bubble on the first postoperative day. In addition,

contamination with even small quantities of detergents can alter the interfacial tension of silicone oil, resulting in a significantly decreased threshold for emulsification.⁸ Thus, contamination with an exogenous agent such as a detergent may yield early opacification followed by later silicone oil emulsification.

Yang et al present an interesting surgical case of a patient with combined tractional and rhegmatogenous retinal detachment treated with vitrectomy and silicone oil endotamponade. Vesicular inhomogeneities within the silicone oil were observed on the first postoperative day, associated with diminished optical clarity of the silicone oil, followed by resolution of the vesicles several days later, and subsequent silicone oil emulsification. It is likely that silicone oil opacification accounted for the findings on the first postoperative day, followed by later emulsification. Given stringent standards in manufacturing medical-grade silicone oil, and moreover the absence of opacification after the use of silicone oil sourced from the same batch at the second surgery in this patient, it is unlikely that the silicone oil formulation inherently caused the early opacification. The most likely etiology of oil opacification was the presence of contaminants introduced into the silicone oil using contaminated surgical instruments, pharmacologics, or infusion solutions. Detergents and silicone oil residue have been detected on reusable vitrectomy instrumentation after routine cleaning and sterilization.⁸ Contaminants causing opacification may have been associated with subsequent silicone oil emulsification, particularly in this patient with postoperative hyphema, an independent risk factor for emulsification. Other possible causes of internal ocular media opacity resolving over a period of days in an aphakic, silicone oil-filled eye include disbursed hyphema, fibrin formation, and inflammatory reaction in the anterior chamber; however, these findings were not reported by the authors in the examination findings. Silicone oil opacification is uncommon, and identification of the inciting agent is generally elusive. Nonetheless opacification is the most plausible cause in this case.

Editor's Note:

Drs. Yang, Kang, Chen, Ning, and Hu present a woman who underwent combined phacoemulsification, vitrectomy, and silicone oil tamponade. On postoperative day 1, innumerable "bubbles" were present within the oil. This case is presented for discussion of these "bubbles," and whether the patient's premature emulsification might be related.

Dr. Yannek Leiderman consults for us and reviews the formulations of silicone oil and the process of emulsification and oil opacification.

He feels that the findings in this patient on the first postoperative day represented silicone oil opacification, and that the opacification was due to contaminants. These possible contaminants may have been introduced by surgical instruments, infusion solutions, or pharmacologics. These same contaminants might have caused the premature emulsification, along with the hemorrhage that was present. Other possibilities promoting silicone oil opacification include fibrin, anterior chamber inflammation, and dispersed hyphema.

Follow-up

We retrospectively analyzed the procedure. Heavy water was not used. The phenomenon was not observed in the following day's operation with the same instrumentation, the same parameters, and the same batch of silicone oil. After visiting the operation room staff and suppliers, we found that the silicone oil was transferred from Shanghai to Shenyang City and directly sent to the operation room the day before surgery. It was in winter, and the outdoor temperature of Shenyang city about -20°C . The next day morning, after less about 12 hours of indoor storage, the silicone oil that we routinely stored in room temperature for at least 48 hours before surgery was used in the operation. Although the silicone oil temperature had been restored to room temperature, no abnormal silicone oil was found during the operation. This low temperature effect may be due to the presence of large amounts of microbubbles in the injected silicone oil.

We thank Drs. Yang, Kang, Chen, Ning, and Hu for their unusual case and Dr. Leiderman for his consultation.

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