

HOW TO CHOOSE THE RIGHT TAMPONADE

Surgeons have several options, and knowing which one will serve the patient best is the key to a successful surgery.

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Intraocular tamponades play an essential role in vitreoretinal surgery, acting as a force to displace fluid away from retinal breaks and plug them to allow the retina to reattach

to the underlying retinal pigment epithelium (RPE).¹ Tamponade agents have evolved over the years, and new innovations are on the horizon. Although choosing the right tamponade is nuanced and case-dependent, this article outlines some general evidence-based guidelines for common clinical scenarios.

THE CHOICES

The most common tamponades in the United States include gas (air, SF₆, C₃F₈), silicone oil, and perfluoro-n-octane (PFO), a heavier-than-water tamponade.

Both SF₆ and C₃F₈ are fluorocarbon gases that are inert, odorless, clear, and low density (Table 1).² The duration of a gas is important to consider when choosing a tamponade because it needs to support retinal breaks until the retinopexy has taken effect. Laser retinopexy requires approximately 24 hours to create an adherent chorioretinal scar and 2 to 3 weeks to develop maximum adhesive force.² Cryotherapy may initially weaken the retina-RPE adhesive forces over the first week due to edema before effectively sealing the retina to the RPE.² The disadvantages of using a gas with a longer duration include increased risk of cataracts and elevated IOP, as well as the inability to travel by plane.²

To simplify the process of preparing intraoperative gas tamponades, Alcon created syringes that can be connected to its vitrectomy machine to auto-purge and auto-fill with pure expansile gas.³ This enables a member of the sterile surgical team to prepare the gas without relying on a non-sterile team member.

Silicone oil is available at two different viscosities, 1,000 centistokes (cSt) and 5,000 cSt (Table 2). Although

patients may see through silicone oil more clearly compared with a gas bubble, silicone oil requires surgical removal from the eye. In addition, it induces a hyperopic shift in phakic patients and, to a lesser degree, in pseudo-phakic patients, and a myopic shift in aphakic patients.

Heavier-than-water tamponades include PFO and heavy silicone oils, the latter of which are not currently approved for use in the United States.

SELECTING THE BEST TAMPONADE

For rhegmatogenous retinal detachments (RRDs), expansile gas at an iso-expansile concentration is typically used if there is no high-grade proliferative vitreoretinopathy (PVR), prior failed reattachment surgery, or inflammatory/infectious processes. Silicone oil may be considered in cases with any of these complicating factors. For combined tractional RDs and RRDs, silicone oil or gas tamponade is typically used. Short-acting gases are increasingly used for macular hole repairs. Using air or no tamponade is acceptable for epiretinal membrane peels.

AT A GLANCE

- For rhegmatogenous retinal detachments, expansile gas is typically used if there is no high-grade proliferative vitreoretinopathy, prior failed reattachment surgery, or inflammatory/infectious processes. In those cases, consider silicone oil.
- Because gas and silicone oil tamponades are buoyant, materials heavier than silicone oil have been used when treating inferior pathology.
- IOP aberrations are among the most common complications of intraocular tamponades.

TABLE 1. TYPE OF GAS TAMPONADES FOR VITREORETINAL SURGERY IN THE UNITED STATES

	Expansile Characteristics	Iso-expansile Percentage	Duration	Precautions
Air	Not expansile		1 week	- Counsel patient that vision will be blurry for the duration of the bubble (be mindful of monocular patients) - Avoid very high altitudes (air travel) or low altitudes (scuba diving) - Avoid nitrous gas anesthesia (risk of rapid expansion of bubble and increased IOP)
SF ₆ (sulfur hexafluoride)	Expands 2x in 2 days	20%	2-3 weeks	
C ₃ F ₈ (perfluoropropane)	Expands 4x in 4 days	14%	6-8 weeks	

For RRDs without PVR, gas tamponade with or without vitrectomy is frequently favored over silicone oil tamponade. Pneumatic retinopexy typically employs 100% expansile gas to treat tears in the superior two-thirds of the retina because the partial fill of the buoyant gas is a less effective plug for inferior pathology.

For RRDs without PVR that undergo vitrectomy, a retrospective study of almost 100 eyes showed that there was no significant difference in rates of recurrent detachment between C₃F₈ and silicone oil fill.⁴ Another retrospective study of more than 500 eyes with RRD found no difference between air and 20% SF₆ tamponade overall, but for eyes with inferior RRDs, tamponade with 20% SF₆ gas had a higher success rate than air.⁵

For RRDs with PVR, two large studies, the Silicone Oil Study and the European Vitreoretinal Society Retinal Detachment Study,^{6,7} investigated the use of gas versus silicone oil tamponade. The Silicone Oil Study, a prospective, randomized multicenter study, showed that patients with RRDs with PVR experienced no significant difference in anatomic or visual outcomes with C₃F₈ versus silicone oil 1,000 cSt at 1 year postoperatively, but patients with SF₆ tamponade had inferior outcomes.^{6,8}

Similarly, the European Vitreoretinal Society Retinal Detachment Study showed that rates of anatomic failure in complex RRD eyes were not significantly different between gas and silicone oil groups.⁷

Smaller retrospective studies of RRD subpopulations have identified significant benefits of one tamponade type over others for specific clinical scenarios. For example, in eyes with pathologic myopia and a staphyloma undergoing vitrectomy for RRD due to a macular hole, C₃F₈ tamponade resulted in better visual outcomes and initial success compared with silicone oil.⁹ This may be because oil does not tamponade the irregular contours of a staphyloma as well as gas. A retrospective study of more than 50 eyes with RRD and PVR that underwent vitrectomy and retinectomy showed that eyes with silicone oil did significantly better than eyes with gas.¹⁰

Several studies have compared 1,000 cSt versus 5,000 cSt tamponade. A study of more than 300 eyes with complex RRDs found no significant difference in

TABLE 2. SILICONE OIL TAMPONADES

	Viscosity (cSt)	Specific Gravity	Approved in the United States
Silicone Oil	1,000	0.97	Yes
Silicone Oil	5,000	0.97	Yes
Perfluoro-n-octane (PFO)	438	1.76	Yes
Densiron 68	3,300	1.06	No
Oxane HD	1,400	1.02	No

outcomes between 1,000 cSt and 5,000 cSt silicone oil.¹¹ In a smaller retrospective study of 82 eyes with complex RRDs, eyes with 5,000 cSt had higher rates of redetachment after silicone oil removal.¹² For diabetic tractional RDs, a retrospective study of 62 eyes found that eyes with silicone oil had significantly lower rates of postoperative vitreous hemorrhage than eyes with gas or no tamponade.¹³

Because gas and silicone oil tamponades are buoyant, materials heavier than silicone oil may be necessary when treating inferior pathology. Two heavy silicone oils are approved for use in Europe, but not in the United States: Densiron 68 and Oxane HD. The Heavy Silicone Oil Study, a randomized control trial that compared Densiron 68 with silicone oil tamponade in eyes with inferior RRDs and PVR, did not find a significant difference in anatomic or functional outcomes.¹⁴ Of note, face-down positioning with gas and silicone oil tamponades for inferior retinal pathology is the current standard to provide tamponade to these areas.

PFO is a heavier-than-water tamponade typically used intraoperatively as a “third hand” to flatten the retina. It has also been proposed as an effective temporary postoperative tamponade in RRDs with giant retinal tears (GRTs) or multiple scattered breaks. However, its use is controversial because prolonged exposure to PFO greater than even 60 minutes can be toxic to the retina.¹⁵

For other retinal pathology, such as macular holes, short-acting gases such as SF₆ are increasingly favored, although current literature lacks consensus on which gas is most effective for hole closure.¹⁶

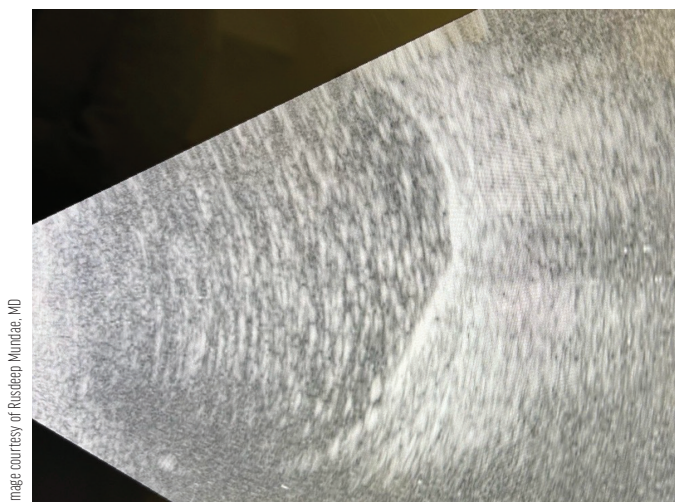


Image courtesy of Ruseep Mordae, MD

Figure. B-scan ultrasound of a patient's eye after silicone removal surgery demonstrates numerous oil droplets remaining in the vitreous cavity, which evaded removal.

TAMPONADE RISKS

IOP aberrations are among the most common complications of intraocular tamponades. Gas is more frequently associated with hypotony and silicone oil with ocular hypertension. Development of cataract is common, regardless of the tamponade.⁶

Retinal slippage occurs more frequently with gas tamponade than silicone oil.¹⁷ Preoperative counseling about activity restrictions with gas tamponade is crucial. Specifically, patients with gas bubbles are advised to avoid air travel, scuba diving, and use of nitrous anesthesia (commonly used during dental procedures) due to the risk of rapid gas expansion. A unique, rare complication of gas tamponade is migration of gas into the optic nerve and intracranial spaces.¹⁸

Complications unique to silicone oil include emulsification with migration into the subconjunctival

AN ILLUSTRATIVE CASE

A 50-year-old man with a fovea-involving rhegmatogenous retinal detachment (RRD) with a temporal giant retinal tear (GRT) with grade C proliferative vitreoretinopathy (PVR) presented with a VA of 20/100 (Figure 1). He underwent a combined scleral buckle and 25-gauge vitrectomy with silicone oil 1,000 cSt tamponade. Five months after his initial surgery, he underwent silicone oil



Figure 1. Widefield fundus imaging of the left eye of our patient demonstrates a temporal GRT spanning from the 12 to 5 clock hours with an associated fovea-involving RRD and a temporal star fold (A). The horizontal raster of a macular OCT showed subretinal fluid involving the macula (B).

removal for mild emulsification. One month later, his retina remained flat, and his VA was 20/150 (Figure 2).

GRTs have typically been managed using silicone oil tamponade.¹ One report estimated that more than 80% of GRTs in England were managed with silicone oil tamponade after vitrectomy.² However, a recent retrospective study of 88 eyes with fresh GRT detachments found that eyes with C_3F_8 tamponade had significantly better post-operative vision and similar rates of redetachment compared with eyes with oil.³ Notably, this study excluded eyes with trauma or high-grade PVR.

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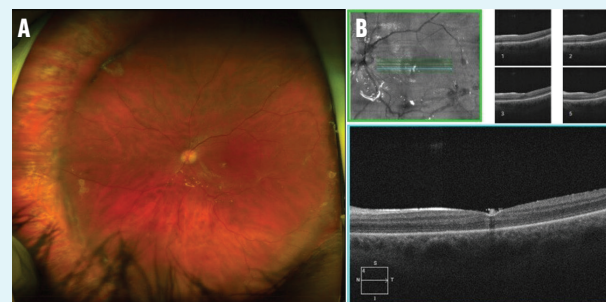


Figure 2. The widefield fundus image of the left eye 6 months after the initial RRD repair surgery and 1 month after silicone oil removal demonstrates a flat retina, laser barricade surrounding the GRT temporally, and an encircling scleral buckle (A). The horizontal raster of a macular OCT shows resolution of subretinal fluid (B).

space, suprachoroidal space, or anterior chamber. Emulsified oil droplets in the anterior chamber increase the risk of glaucoma, and residual droplets may remain even after attempted surgical removal of silicone oil (Figure). In addition, after oil removal, there is a risk of redetachment or vision loss likely related to silicone oil toxicity.¹⁹ Rarely, silicone oil is toxic to retinal ganglion cells either by intraretinal migration of oil or direct contact with cells, causing vision loss and thinning of inner retinal layers.²⁰ ■

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