

## Sandwich Technique with Anterior Silicone Oil and Posterior Perfluorocarbon Liquid for Intraoperative Retinal Stabilization in Eyes with Large Retinal Breaks

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### Abstract

During retinal surgeries, the presence of large retinal defects or breaks (giant retinal tears or retinotomies  $\geq 3$  clock hours) requires the use of perfluorocarbon liquid (PFCL) to stabilize the posterior retina. Thereafter, direct PFCL-oil exchange is preferred to avoid posterior slippage of the retina. However, in an eye filled with PFCL, fluid currents at the surface of the PFCL pose a few problems when laser is attempted. Multiple bubbles are formed due to fluid currents, and the fluid jet from the infusion port may continually dislodge the free end of the retina despite the presence of PFCL. This effect is accentuated when instruments are exchanged or if the active port is unoccluded. On the other hand, if laser is postponed until the eye is filled with oil, fluid accumulation may occur under the macula, as posterior tamponade is absent. We present a modified technique that entails the use of a “sandwich” of anterior SO and posterior PFCL to comfortably perform laser in a well-formed closed vitreous chamber with continuous maintenance of retinal attachment.

**Keywords:** Giant Retinal Tear; Perfluorocarbon Liquids; Retinal Detachment Surgery; Retinectomy; Silicone Oil

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### INTRODUCTION

One of the most challenging surgical scenarios for a retinal surgeon is the presence of large retinal defects or giant retinal tears (GRTs). In these eyes, intraoperative slippage of the retina may occur even after achieving retinal reattachment with fluid-air exchange (FAE) and may be accompanied by entrapment of sub-retinal fluid (SRF)

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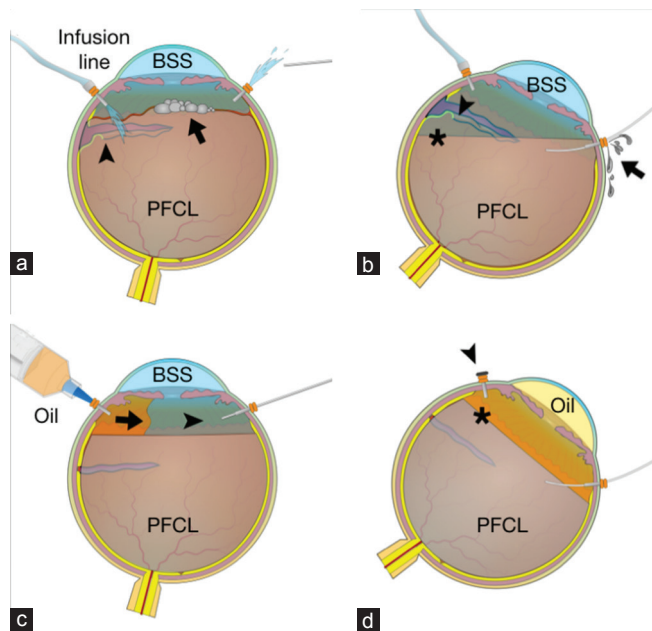
in the posterior pole. This slippage of the retina can be attributed to the lack of support to the posterior retina in an air-filled eye. Perfluorocarbon liquids (PFCLs) are thus used to support the posterior retina.<sup>[1]</sup> Continuous posterior tamponade with PFCL can be achieved through direct exchange of PFCL with silicone oil (SO).<sup>[2,3]</sup> When using direct PFCL-SO exchange, surgeons have two options regarding the timing of performing the laser procedure. Laser can be performed in a PFCL-filled eye before PFCL-SO exchange (Technique A) or after PFCL-SO exchange in a SO-filled eye (Technique B). However, each technique presents unique difficulties to the surgeon.

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In Technique A, the problems encountered are (a) repeated formation of multiple small bubbles at the PFCL surface due to formation of fluid currents, which interfere with visualization [arrow, Figure 1a]. (b) The obliquely fashioned sclerotomy of the infusion port does not direct the fluid jet to the center of the vitreous cavity. The jet is often directed tangentially toward the inferior eye wall. A momentary gush of fluid flowing into the vitreous cavity from the inferior infusion port to maintain the intraocular pressure (IOP) once the active superior port is disengaged, has sufficient momentum to wedge its way down to the free retinal edge coursing between the PFCL meniscus and inferior eye wall. This fluid jet from the infusion port can dislodge large retinal defects [arrowhead, Figure 1a]. (c) When using curved endolaser probes with an external diameter smaller than the diameter of the port, continuous leakage of balanced salt solution (BSS) and PFCL loss cannot be eliminated [arrow, Figure 1b]. (d) Rotation of the eye to perform laser in the periphery is difficult as the retinotomy edge in the superior half is elevated due to shifting of PFCL [arrowhead, Figure 1b]. Therefore, current literature suggests that a PFCL-filled eye is best maintained in the primary position to avoid spill over and jet-related dislodgement.<sup>[4]</sup> All these problems can



**Figure 1.** Fluid currents lead to formation of bubbles over perfluorocarbon liquid (PFCL) (arrow, a); infusion jets may open the retinal break below PFCL (arrowhead, a). Globe rotation leads to PFCL loss (arrow, b), inadequate tamponade (asterisk, b) & lifting of breaks (arrowhead, b). Oil is injected above PFCL (arrow, c); the fluid is removed passively (arrowhead, c). PFCL-oil interface remains parallel to the iris despite globe rotation (asterisk, d) and the break remains flat. The need for continuous infusion is eliminated; the infusion port may be plugged (arrowhead, d). BSS, balanced salt solution.

be attributed to the low viscosity of PFCL that does not aid in restricting fluid currents.

In Technique B, because PFCL is completely removed and the eye is filled with SO during the laser procedure, the retina with a large anterior defect can slip posteriorly. Due to the absence of posterior tamponade, SRF can accumulate in the macula by the time laser is completed. Removal of the posteriorly trapped SRF is difficult after completing the laser procedure. These challenges can be attributed to the low specific gravity and high buoyancy of oil.

Therefore, to avoid problems related to Technique A, a more viscous fluid is required close to the ports anteriorly. At the same time, to avoid problems related to Technique B, a fluid with high specific gravity is required to provide tamponade posteriorly. Two different fluids are required to achieve these goals, and the objectives cannot be met in a completely PFCL-filled eye or completely oil-filled eye. Therefore, our “sandwich technique” of maintaining oil anteriorly and PFCL posteriorly during laser addresses the above problems.

## SURGICAL METHOD

Retinal detachment (RD) surgery proceeds in a routine manner until the point where PFCL is injected. PFCL is filled just beyond the most anterior aspect of the retinal defect. Thereafter, the fluid infusion line is disconnected from the infusion cannula. A SO-filled plastic syringe linked to the automated infusion pump is connected to the infusion port and held in place by an assistant. The surgeon holds the endoilluminator in the left hand and a flute needle in the right. With controlled injection of SO [arrow, Figure 1c], BSS above the PFCL bubble is removed with the flute needle [arrowhead, Figure 1c]. Care is taken to maintain the tip of the flute needle above the PFCL bubble at all times to avoid PFCL aspiration. In this manner, fluid-SO exchange is performed above the PFCL bubble. The anterior part of the eye along with the circumferential ring of fluid at the PFCL-SO interface anterior to the retinal defect is completely “dried” of fluid. Both PFCL and SO are hydrophobic; therefore, with repeated passage of the flute needle across the interface, they stay firmly together in a single bubble. BSS is not hydrophobic and remains outside the combined PFCL-SO bubble.<sup>[4]</sup>

As with PFCL-air exchange, complete removal of fluid “anterior” to the PFCL bubble is essential.<sup>[5,6]</sup> In case of aphakia, fluid in the anterior chamber is also replaced with SO by passing the flute needle anteriorly from behind the pupil. Since the vitreous is now a closed chamber with no port for egress, constant monitoring of the IOP and prevention of IOP spikes is necessary.

SO syringe is then removed and the infusion port is closed with a plug [arrowhead, Figure 1d]. With the endoilluminator in one hand and endolaser in the

other, endophotocoagulation is performed. Rotation of the eye in any direction was facilitated without the fear of PFCL run-off or subretinal migration. In contrast to PFCL-fluid interface in an open vitreous cavity that remains horizontal irrespective of the globe position [asterisk, Figure 1b], the PFCL-SO interface in this closed cavity is parallel to the iris plane even with globe rotation [asterisk, Figure 1d]. The interface shifts very slowly owing to the viscosity of SO, which provides sufficient time for the endolaser procedure. After endophotocoagulation, the process of removing any remaining fluid from the interface is repeated with the flute needle, and the PFCL-SO exchange is continued in the routine manner until PFCL has been completely removed.

## RESULTS

A retrospective analysis was performed after obtaining informed consents from the patients and clearance from the Institutional Ethics Committee of Aravind Eye Hospital. Files of 21 patients who underwent vitreous surgery in a single eye for GRT-related RD or RD which required retinotomy that exceeded three hours between February 2016 and May 2017 by a single surgeon (MVG) at Aravind Eye Hospital, Pondicherry, India were reviewed. Of the initial ten eyes that underwent the conventional procedure, four eyes had infusion jet related retinal dislodgement. When fluid-SO exchange was performed above the PFCL bubble in the subsequent 11 eyes, no retinal dislodgement was noted ( $P = 0.03$ ).

## DISCUSSION

Retinal reattachment is surgically achieved by indirectly manipulating the retina using multiple fluids: BSS, PFCL, SO, and air.<sup>[1,7]</sup> A working knowledge of the physical properties of the fluids mentioned and their optimal use within the vitreous cavity help in achieving the surgical goal.<sup>[8]</sup> In the presence of large defects (GRT or retinotomy  $\geq 3$  clock hours) together with RD, the challenge for the surgeon is attaining and maintaining retinal re-apposition to the retinal pigment epithelium.<sup>[4]</sup>

When SO is used as tamponade for eyes with rhegmatogenous RD, the commonly employed surgical sequence is drying of the whole vitreous cavity with air by performing FAE, followed by performing endolaser, and concluding the surgery by injecting SO.<sup>[9]</sup> This technique is quicker than the PFCL-SO exchange. However, with this technique, after FAE and before injecting SO, the entire vitreous cavity is filled with air, and retinal support is provided by the air bubble alone. While small breaks are closed and stabilized by an air bubble, large retinal defects located anteriorly are not adequately supported by air. This technique may be

indicated for stabilizing retinal defects at or behind the equator; anterior retinal defects tend to slip and cause posterior retinal folds when air alone is employed for support.<sup>[9,10]</sup>

The other commonly employed technique during RD surgery is using PFCL to stabilize the posterior retina followed by a direct PFCL-SO exchange. As mentioned earlier, performing laser in an eye completely filled with oil or in an eye that is completely filled with PFCL presents many challenges. To overcome these difficulties, the “sandwich technique” was employed with SO anteriorly and PFCL posteriorly during the laser procedure.

The advantages of using the sandwich technique can be summarized as follows. First, because SO present anteriorly has higher viscosity and flows more slowly than BSS or PFCL, there is no easy loss of the oil from the sclerotomy ports. When volume loss is negligible, the need for continuous replacement is eliminated. Therefore, it stands to reason that escape currents, turbulence, and formation of PFCL droplets are also absent. Obscuration of clear viewing due to continuous overflow of low viscosity fluids from within the eye through the sclerotomy ports or graft margins (in case of combined keratoplasty) over the visual axis is eliminated. Retinotomy dislodgement by the BSS jet from the infusion port is also avoided. Second, as PFCL is maintained posteriorly, continuous posterior tamponade is provided, and there is no posterior accumulation of SRF or slippage of the retina during the laser procedure. When employing the sandwich technique, the eye is a tight closed chamber and rotation is facilitated for fluid removal or peripheral laser procedure [Figure 1d].

Fluid-SO exchange above the PFCL does not require any special instruments or agents. The procedure entails performing a few surgical steps ahead of endophotocoagulation followed by PFCL-SO exchange in the routine manner. With the mentioned technique, it is prudent to close the superior sclerotomies when fluid infusion is disconnected and substituted with SO. Small bubbles in the SO syringe need to be eliminated to maintain a clear view. As with direct PFCL-oil exchange, a limitation of the current technique is that occlusion of the flute needle could occur with repeated passage through the oil to reach the PFCL. The patency of the flute has to be confirmed during PFCL-oil exchange.

In conclusion, with the sandwich technique, stabilization of the retina within a closed vitreous cavity is achieved by exploiting the differing physical properties of two immiscible liquids. Compared with a PFCL-filled or an oil-filled eye, retinal stabilization is superior and laser photocoagulation is more comfortable in closed vitreous chamber packed with oil anteriorly and PFCL posteriorly.

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## Conflicts of Interest

There are no conflicts of interest.

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