Intraoperative OCT-Assisted Subretinal Perfluorocarbon Liquid Removal in the DISCOVER Study

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BACKGROUND AND OBJECTIVE: To assess the role for intraoperative optical coherence tomography (iOCT) during subretinal perfluoro-n-octane (PFO) removal and evaluate it as an assistive technique during surgical maneuvers.

MATERIALS AND METHODS: DISCOVER is a prospective study examining microscope-integrated iOCT systems in ophthalmic surgery. The authors report a technique utilizing iOCT guidance and feedback for surgical removal of chronic subretinal PFO.

RESULTS: In this technique, real-time iOCT feedback successfully guided surgical maneuvers to facilitate removal of PFO. Due to the chronicity of the PFO, it was loculated and resistant to multiple maneuvers. Utilizing real-time feedback, additional maneuvers were attempted with feedback to the surgeon regarding the success of removal. Postoperatively, visual acuity improved with anatomic normalization.

CONCLUSION: Microscope-integrated iOCT with real-time feedback provided important information to the surgeon that helped facilitate subretinal PFO removal and guided surgical maneuvers.


INTRODUCTION

Perfluoro-n-octane liquid (PFO) is a synthetic compound that is widely used in vitreoretinal surgery. PFO has a number of characteristics that facilitates its use in retinal detachment repair, including high specific gravity, low surface tension, low viscosity, and optical clarity. The high specific gravity of PFO enables the flattening of detached retina and displacement of subretinal fluid. The low surface tension and viscosity of PFO facilitate its injection and removal. The unique physical properties of PFO has helped simplify surgical procedures and improved the safety, specifically in complicated cases.

Despite the benefits of PFO, one of the major surgical complications that may be encountered is retained subretinal PFO. Retained subretinal PFO results in a localized absolute scotoma; this mandates surgical removal of symptomatic subretinal PFO, particularly when localized in the fovea. Multiple approaches to removal of subretinal PFO have been described, but it remains a challenging surgical situation to resolve.

Visualization of the subretinal PFO and confirmation of removal is currently limited primarily to direct visualization during surgery. Intraoperative optical coherence tomography (iOCT) now allows surgeons to visualize retinal anatomy in real time. In this report, we present a case of retained subfoveal PFO managed with iOCT-assisted pars plana vitrectomy (PPV). iOCT helped to identify loculated PFO that was resistant to initial maneuvers for displacement.
Subsequently, iOCT aided in performing additional surgical maneuvers that resulted in successful and safe removal of the subfoveal PFO.

**TECHNIQUE**

A 59-year-old phakic woman presented with a history of a giant retinal tear with inferotemporal re-detachment with proliferative vitreoretinopathy (PVR) and subfoveal PFO. Three months prior, she had undergone initial repair with a scleral buckle, PPV, PFO, octafluoropropane (C3F8) gas, and endolaser. Visual acuity was 20/400, and she had a moderately dense cataract on presentation. Surgical repair was recommended, and the patient elected to enroll in the DISCOVER study, a prospective institutional review board–approved study examining microscope-integrated iOCT systems in ophthalmic surgery, as previously described.10

The patient underwent phacoemulsification with intraocular lens placement and subsequent vitrectomy. Upon inspection, there were significant inferior PVR membranes, which were removed with the aid of triescence staining (video available at www.Healio.com/OSLIRetina). Attention was then turned to the subretinal PFO, which was visualized with the microscope-integrated iOCT system (Rescan 700; Carl Zeiss Meditec, Jena, Germany). A 41-gauge needle was utilized to create a subretinal bleb via transreti-

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**Figure.** Intraoperative optical coherence tomography (iOCT) for subretinal perfluoro-n-octane (PFO) removal. (A) Macular photograph demonstrating chronic retained subfoveal PFO. (B) Preoperative OCT visualization of subretinal PFO. (C) En face view (left) with corresponding iOCT five-line raster (right) scan over macula depicting subretinal fluid present at beginning of case. (D) Intraoperative en face view of subretinal bleb induction with 41-gauge cannula (left) and iOCT one-line raster scan (right) demonstrating subretinal bleb approaching subretinal PFO. (E) Intraoperative en face view of inferior proliferative vitreoretinopathy (PVR; left) with iOCT horizontal and vertical scan (right) demonstrating detached retina, PVR, and triescence staining. (F) OCT at 3 months postoperatively shows absence of PFO, inner segment/outer segment junction abnormalities, and trace cystoid edema.
nal approach in the superotemporal macula (video available at www.Healio.com/OSLIRetina). The iOCT system was used to aid in the visualization of the progression of the subretinal bleb toward the subfoveal PFO. As the bleb approached the subfoveal PFO, en face visualization appeared to show displacement of the PFO. However, iOCT confirmed that the PFO was loculated within the retinal tissue and did not dislocate despite bleb induction. It was unclear whether the PFO was truly encysted within the retinal tissue or simply quite adherent to the surrounding tissue. In an attempt to displace the PFO into the bleb, preretinal PFO was placed without successful displacement of the subfoveal PFO.

In an effort to gain access to the loculated PFO, attention was redirected to the inferior detachment. Despite maximal membrane removal, the retina was inherently stiff and required a 180° inferior retinectomy. Retinal reflection with direct removal of subretinal PFO was considered; however, due to the atrophic nature of the peripheral retina, this was not safely feasible.

Given the persistent subretinal PFO, iOCT-guided aspiration of PFO with parafoveal entry with a 41-gauge needle was successfully implemented to remove the retained liquid. Pre-retinal PFO was again added to flatten the peripheral retina. Endolaser was performed to the retinectomy edge. An air-fluid exchange was performed, and silicone oil was instilled. All three sclerotomies were sutured.

Three months after surgery, OCT confirmed stable macular attachment without subretinal PFO. Minimal intraretinal fluid was present with subfoveal ellipsoid zone loss. Six months after initial surgery and 3 months after silicone oil removal, the retina remains attached without recurrence of subretinal fluid with improvement in visual acuity to 20/125.

**DISCUSSION**

Subretinal PFO is a challenging postoperative surgical issue to manage optimally. Several techniques for managing subretinal PFO have been described with varying results, including direct aspiration using various cannulas, spontaneous peripheral displacement of PFO, and removal through a therapeutic macular hole. The removal of retained PFO is reported to improve visual acuity. The initial approach in this case was to develop a subretinal bleb of fluid to facilitate displacement and subsequent removal of subfoveal PFO. This was initially attempted to avoid juxtafoveal or direct foveal manipulation. Following insufficient displacement of PFO, iOCT guidance was then utilized for direct aspiration.

The utilization of iOCT aided in several important parts of this surgery: evaluation of PVR membranes and subsequent removal, initial identification of subretinal PFO, assistance with subretinal bleb formation with a 41-gauge cannula, intraoperative evaluation of loculated PFO in the setting of decreased surgical view secondary to corneal edema, direct guidance of 41-gauge parafoveal PFO removal, and finally, confirmation of surgical goal of complete subfoveal PFO removal and complete flattening of the PVR detachment.

Intraoperative OCT provided feedback during the case that demonstrated the persistence of the subretinal PFO, even when there were no clear signs of retained PFO under direct en face visualization. Multiple manipulations were attempted to remove the subretinal PFO but were proven unsuccessful with iOCT, although the surgeon’s view was inconclusive. Other studies have demonstrated the utility of iOCT during surgical decision making and the discordance between en face surgeon perception and iOCT visualization of tissue relationships.

Ultimately, in comparison to standard PPV with direct en face visualization, iOCT-assisted PPV enabled effective completion of the surgical goals of repairing the PVR detachment and removal of subfoveal PFO and provided real-time confirmation that the surgical goals were met. Further research is needed to provide additional information on the optimal use of iOCT during subretinal PFO removal.

**REFERENCES**