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

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Abstract

Background and Objective—To assess the role for intraoperative OCT (iOCT) during subretinal perfluoro-n-octane (PFO) removal and evaluate it as assistive technique during surgical maneuvers.

Study Design/Materials and Methods—The DISCOVER study is a prospective IRB-approved study examining microscope-integrated iOCT systems in ophthalmic surgery. We provide a report of 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 the PFO. Due to the chronicity of the PFO, it was quite loculated and resistant to multiple maneuvers. Utilizing real-time feedback, additional maneuvers were attempted with feedback to the surgeon regarding the success of that removal. Postoperatively, visual acuity improved with anatomic normalization.

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

Keywords

PFO; perfluorocarbon; retinal detachment; optical coherence tomography; intraoperative OCT

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.¹ 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

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removal. The unique physical properties of PFOs have 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;^{2,3} 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.⁴⁻⁹

Visualization of the subretinal PFO and confirmation of removal is currently limited primarily to direct visualization during surgery. Intraoperative OCT (iOCT) now allow surgeons to visualize retinal anatomy in real-time. In this report, we present a case and show a video 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 presents 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, pars plana vitrectomy (PPV), PFO, 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 IRB-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 performed. Upon inspection, there were significant inferior PVR membranes, which were removed with the aid of triescence staining (Supplemental video). Next, attention was turned to the subretinal PFO. Subretinal PFO was visualized with the microscope-integrated iOCT system (Rescan 700, Zeiss, Oberkochen, Germany). A 41-gauge needle was utilized to create a subretinal bleb with transretinal approach in the superotemporal macula (Supplemental video). The iOCT system was used to aid in the visualization of the progression of the subretinal bleb towards 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. Attempting 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 re-directed to the inferior detachment. Despite maximal membrane removal, the retina was inherently stiff and required a 180-degree 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.

Due to the persistent subretinal PFO, λ OCT-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 challenging postoperative surgical issue to optimally manage. Several techniques for managing subretinal PFO have been described with varying results, including direct aspiration using various cannulas,⁴⁻⁶ spontaneous peripheral displacement of PFO,⁷ and removal through a therapeutic macular hole.⁸ The removal of retained PFO is reported to improve visual.^{4,9} 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, λ OCT guidance was then utilized for direct aspiration.

The utilization of λ OCT 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 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 lastly, confirmation of surgical goal of complete subfoveal PFO removal and complete flattening of the PVR detachment.

λ 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 λ OCT, although the surgeon's view was inconclusive. Other studies have demonstrated the utility of λ OCT during surgical decision-making and the discordance between *en face* surgeon perception and λ OCT visualization of tissue relationships.¹¹

Ultimately, in comparison to standard PPV with direct *en face* visualization, λ OCT-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 λ OCT during subretinal PFO removal.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Intraoperative optical coherence tomography (OCT) for Subretinal perfluoro-n-octane removal

A – Macular photo demonstrating chronic retained subfoveal perfluoro-n-octane; B – Preoperative OCT visualization of subretinal perfluoro-n-octane; C – En face view (left) with corresponding intraoperative OCT 5-line raster (right) scan over macula depicting subretinal fluid present at beginning of case; D – Intraoperative *en face* view of subretinal bleb induction with 41G cannula (left) and iOCT 1-line raster scan (right) demonstrating subretinal bleb approaching subretinal perfluoro-n-octane; E – Intraoperative *en face* view of inferior PVR (left) with iOCT horizontal and vertical scan (right) demonstrating detached retina, PVR, and trisience staining; F – OCT at POM3 shows absence of perfluoro-n-octane, IS/OS junction abnormalities and trace cystoid edema.