

Iatrogenic macular hole following PFCL injection: Implications of retinal dimpling as an intraoperative indicator

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ABSTRACT

Background: Perfluorocarbon liquid (PFCL) revolutionized retinal detachment (RD) management in vitreoretinal surgery but introduced unique risks. Complications like subretinal migration are documented, yet specific warnings for macular hole (MH) formation during PFCL injection are lacking.

Case presentation: In a rhegmatogenous RD case, a localized retinal dimpling during PFCL jet stream injection, preceded subsequent complications—an immediate MH and subretinal PFCL migration. Subsequently, an internal limiting membrane peeling with PFCL mobilization was performed successfully managed the situation. Post-surgery, optical coherence tomography (OCT) confirmed a closed MH with improved vision.

Conclusion: This case report not only sheds light on a previously undocumented complication associated with PFCL injection but also underscores the critical need for adherence to proper injection technique to minimize traumatic effects. Understanding the mechanism underlying this complication and implementing corrective measures are essential for enhancing intraoperative strategies and minimizing adverse outcomes in retinal surgeries involving PFCL.

1. Introduction

The use of perfluorocarbon liquid (PFCL) in vitreoretinal surgery has revolutionized the management of complex retinal detachments (RD).^{1–3} While PFCL offers significant benefits in facilitating surgical maneuvers and providing a tamponade effect, it also presents potential risks if not used with caution. The existing literature has documented complications associated with PFCL, such as sub-retinal migration and residual PFCL.^{4,5} However, there are limited case reports depicting the emergence of a macular hole during the injection procedure. The primary objective of this case report is to highlight the significance of the "Dimple Sign" observed during PFCL injection as a potential early indicator of MH formation, a complication that has not been previously associated with this sign. While retinal dimpling is a recognized observation during various intraocular maneuvers, its identification during PFCL injection may serve as a valuable warning sign for surgeons, prompting immediate alteration of the injection trajectory and force to potentially prevent the development of MH.

2. Case description

A 58-year-old Male patient presented with left eye (OS) decreased vision (best-corrected visual acuity [BCVA]: 20/200 and was diagnosed with OS rhegmatogenous RD necessitating surgical intervention. Intraoperatively, during the injection of PFCL to facilitate retinal reattachment, a distinctive observation was made. Notably, a dimpling effect manifested on the retina precisely at the location where the PFCL jet was directed. This peculiar phenomenon served as an early indicator of subsequent complications.

Following the appearance of the retinal dimpling, the situation rapidly progressed as an MH developed immediately, accompanied by subretinal migration of PFCL. The presence of MH was confirmed on intraoperative optical coherence tomography (iOCT) (Fig.1A). To address the complication, An internal limiting membrane (ILM) peeling was executed, and subfoveal PFCL was mobilized peripherally via the injection of an additional PFCL bubble over the posterior pole. A peripheral drainage retinotomy was made to aspirate the subretinal PFCL. This was followed by fluid-air exchange, PFCL-air exchange, and precise endolaser application around the retinotomy site.

Three weeks post-surgery, OCT revealed a closed MH (type 1)

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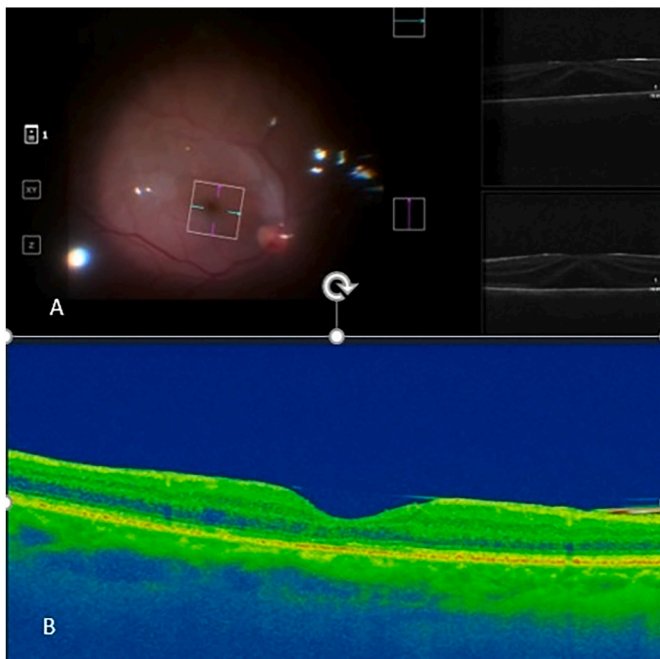


Fig. 1. Intraoperative optical coherence tomography (iOCT) of the patient demonstrating the full-thickness macular hole (FTMH) (A) which closed three weeks after the surgery as noted on the post-operative OCT (B).

(Fig.1B), indicating successful resolution of the iatrogenic complication. The patient exhibited no further complications during the follow-up period with BCVA improving to 20/60.

3. Discussion

The occurrence of an iatrogenic MH during PFCL injection in vitreoretinal surgery is a rare yet significant complication that demands attention and understanding. An iatrogenic MH may develop as a consequence of the PFCL jet's forceful impact on the delicate retinal tissue. PFCL, while instrumental in managing complex RD, possesses characteristics that, when improperly directed or at excessive pressure, can lead to tissue damage.^{4,5}

The use of PFCL in vitreoretinal surgery has undoubtedly enhanced surgical outcomes, yet it is not without associated risks. Subretinal migration and residual PFCL are recognized complications documented in the literature.⁴⁻⁶ The migration of PFCL into the subretinal space can lead to various sequelae, including MHs,⁶ as seen in this case. Furthermore, PFCL-related complications extend beyond intraoperative events, with residual PFCL presenting challenges post-surgery, potentially causing toxic effects and impairing visual recovery.⁴⁻⁶ Studies have reported cases of persistent subretinal PFCL leading to delayed visual recovery, outer retinal damage, and the need for subsequent interventions.⁶⁻⁹ The occurrence of MHs due to PFCL has been documented, albeit without a specific early sign (retinal dimpling) as described in this case.¹⁰ Furthermore, in our particular case, the presence of MH was verified using iOCT and subsequently addressed during the primary surgical procedure by performing an ILM peeling. However, in the aforementioned case, the presence of MH was confirmed through post-operative OCT, leading to the patient undergoing a subsequent surgical intervention one month later, during which the ILM was peeled. Understanding these documented complications emphasizes the need for a comprehensive understanding of PFCL-associated risks and the importance of vigilance during surgical procedures to mitigate these risks.

Understanding the pathophysiology of this complication involves considering the impact of the PFCL jet on the structural integrity of the

retina. The forceful application of PFCL might lead to focal stress concentration, creating a local area of increased pressure or shearing force on the retinal tissue. The retinal dimpling likely manifests when this forceful impact causes a transient, minor depression in the compressible retina tissue, which may be accompanied by an optical reflex. It is important to note that this typically represents a transient phenomenon and does not universally indicate trauma or damage to the retina. In our case, as demonstrated in the video and confirmed on iOCT, we observed that this transient depression had the potential to evolve into a MH.

While the retinal dimpling was observed in this case, indicating localized retinal depression due to forceful PFCL impact, its significance lies in serving as a potential warning sign for surgeons to reassess and modify their injection technique. Adjusting the speed, direction, and proximity of the PFCL jet based on intraoperative feedback can potentially mitigate the force exerted on the retina and reduce the risk of complications. To ensure a controlled and least traumatic injection, the following measures should be implemented: 1.) Gradual Injection Speed- Initiate the injection at a controlled and gradual speed to minimize the force exerted on the retina upon contact with PFCL; 2). Safe Distance Maintenance- Maintain a safe distance from the retina, particularly the macula, to prevent direct trauma. Directing the PFCL jet towards the optic nerve rather than the macula can reduce the risk of complications; 3). Trajectory Adjustment: Avoid directing the PFCL jet towards the fovea and re-direct it towards the optic nerve, ensuring that the force is distributed evenly and away from critical retinal structures; 4). Intraoperative Monitoring and Prompt Adjustment: Continuously monitor intraoperative feedback, such as the appearance of a localized depression/dimpling or any abnormal retinal changes, and promptly adjust the injection technique accordingly to minimize the risk of complications. Recognizing the significance of proper injection technique is paramount in preventing the development of iatrogenic MH and other associated complications. By adhering to these preventive measures, surgeons can minimize the risk of direct trauma to the macula and optimize surgical outcomes when using PFCL.

The case description highlights the swift progression from the observation of the retinal dimpling to the development of an MH and the subsequent surgical management employed to address this complication. The surgical approach involved not only addressing the macular hole but also managing the subretinal PFCL migration. ILM peeling, peripheral PFCL mobilization, and a carefully crafted drainage retinotomy were essential components of the surgical strategy. The subsequent series of exchanges and laser application around the retinotomy site contributed to the overall success of the intervention. In managing subretinal PFCL, various techniques have been described.⁴ Direct aspiration using small-gauge cannulas or needles, ranging from 25 to 50 G, is commonly employed.⁴ The aspiration can be performed at the edge or on top of the PFCL bubble. Specialized tools like a 50-G glass micropipette or a 40-G beveled inner microneedle aid in penetration and stabilization of the retina.^{11,12} Alternative methods involve displacement of PFCL, either with removal through a retinotomy (present case) or displacement without removal.⁴ Inducing a macular retinal detachment (RD) through a retinotomy allows gentle flushing or injection of saline to remove the PFCL bubble.⁴ Another approach is creating an RD at the posterior pole and inferior periphery, followed by fluid-air exchange, allowing PFCL droplets to displace towards the inferior periphery.⁴

Conclusion

In conclusion, the current case report highlights the importance of careful administration of PFCL during vitreoretinal surgery to prevent potential complications, such as iatrogenic MH formation. Proper injection technique, vigilance, and intraoperative feedback are crucial in minimizing adverse outcomes and optimizing surgical outcomes when using PFCL.

Research ethics and patient consent

The study was conducted according to the principles of the Declaration of Helsinki and the patient signed an informed consent form.

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CRediT authorship contribution statement

Aditya Kelkar: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mounika Bolisetty:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Sukanya Mondal:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ajoc.2024.102122>.

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