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# Short-term postoperative perfluoro-n-octane tamponade for pediatric recurrent retinal detachment

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## Abstract:

We report a case with multiple recurrences of retinal detachment (RD) with severe proliferative vitreoretinopathy in a 12-year-old child who underwent vitrectomy using a heavy liquid perfluoro-n-octane (PFO) as a short-term postoperative tamponade. He had an encircling band and three vitrectomies with gas, followed by silicone oil tamponade for retinal redetachment prior to the use of PFO as a short-term tamponade. Short-term PFO tamponade was used in which inferior retinal reattachment was considered to be difficult with conventional gas or silicone oil tamponade, especially in regard to proper postoperative posturing. The PFO was left in the eye for 1 week, and the retina remained reattached after removal of the PFO which was replaced with silicone oil tamponade in this case. PFO appears feasible and tolerable as a short-term postoperative tamponade in the management of complex pediatric RD.

## Keywords:

Heavy liquid, pediatric retinal detachment, short-term perfluoro-n-octane

## Introduction

How to surgically approach pediatric retinal detachment (RD) has always been a challenge for vitreoretinal surgeons, as such children have a high risk of proliferative vitreoretinopathy (PVR) formation. Stanley Chang's research and development pioneered the use of perfluoro-n-octane (PFO) for the management of difficult retinal pathologies such as PVR.<sup>[1,2]</sup> Recently, the utilization of PFO as a vitreous substitute for tamponade has shown encouraging results, especially in highly complex procedures, as with PVR and rhegmatogenous RD with inferior or multiple breaks.<sup>[3-8]</sup> PFO has an acceptable safety profile, especially when used for short and medium durations.<sup>[4,6-10]</sup> In a recent pediatric study,<sup>[5]</sup> short-term postoperative tamponade with PFO was effective in pediatric cases with complex RD

in which proliferation exists in the inferior or posterior retina. The aim of the present case report is to describe a treatment option with short-term PFO tamponade for recurrent RD in children, thus increasing the body of evidence in support of such use.

## Case Report

A 12-year-old male student initially presented to our eye clinic with curtain-like shadow in the left eye for 2 weeks and subsequent loss of central vision for 2 days. He had high myopia, with -6D in both eyes, but was otherwise a healthy person. He denied any history of trauma or previous ocular disease or surgery. On examination, visual acuity was counting finger in the left eye and 1.0 decimal in the right eye. Left-eye funduscopy revealed subtotal RD involving the macula with inferior PVR [Figure 1a]. The left eye was found to have a normal fundus. He underwent combined encircling band and primary

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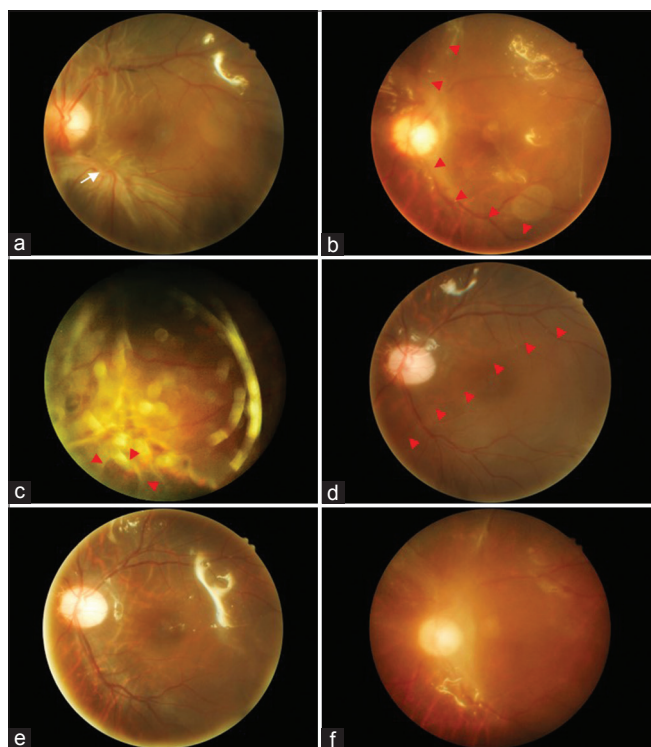
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vitrectomy due to the stiff retina with inferior PVR changes. Drainage retinotomy was performed for inferior bullous detachment. Postoperatively, the retina was flattened, and gas tamponade with 20% SF<sub>6</sub> was used. Five months later, he had recurrence of RD in the left eye [Figure 1b] and underwent a second vitrectomy and tamponade with silicone oil. Intraoperatively, he was found to have PVR changes involving the inferior half of the retina, and these were not supported by an encircling band. A superior break posterior to the buckle was noted, probably of superior vitreous base acting as the vector by which contractile forces were transmitted to the peripheral anterior retina, resulting in traction and tearing superiorly. At the 1-month postoperative follow-up, he was noted to have recurrence of inferior RD with severe proliferation behind the silicone oil on the inferior retinal surface [Figure 1c]. Thus, he underwent a third vitrectomy with inferior retinectomy. This was again followed with silicone oil. At 4-month postoperation, the left eye was found to have inferior RD with no obvious periphery break [Figure 1d]. Because of the repeated detachment from the inferior PVR, despite the previous use of scleral buckle and silicone oil tamponade, we decided to use PFO as a postoperative

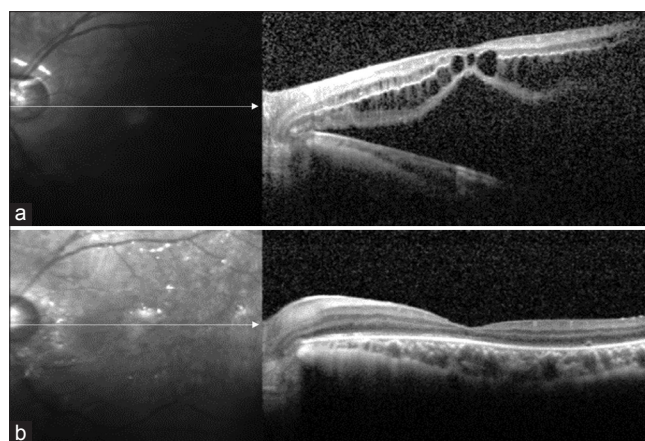
tamponade. During the fourth vitrectomy, the silicone oil tamponade was removed followed by peeling of the inferior preretinal membrane and removal of the subretinal band. There was inferior shallow detachment with macular involvement, but no retinal tears were seen. We performed retinectomy, drainage of subretinal fluid, and laser photocoagulation. PFO was used as a postoperative tamponade at the end of the surgery. The patient was instructed to rest in a supine or sitting position after the surgery. One week postoperatively, optical coherence tomography scan showed complete resolution of the subretinal fluid [Figure 2] and the well-attached retina [Figure 1e]. The PFO was removed 1 week postoperatively and replaced with silicone oil tamponade. Since then, he has developed posterior subcapsular opacification in the left lens and had a phacoemulsification and intraocular lens implantation a few months later. The left retina remained reattached at the last follow-up. The best-corrected visual acuity of the left eye at the last visit was 0.1 (−6.5D × −1.0 at axis 10). After more than 2 years of follow-up, the left eye developed posterior capsular opacity and epiretinal membrane around the optic disc [Figure 1f]. The unaided visual acuity was 0.05 at the last follow-up.



**Figure 1:** Color fundus photograph of the left eye. (a) Initial presentation demonstrating subtotal retinal detachment with proliferation vitreoretinopathy located inferiorly (white arrow). (b) Retinal detachment (demarcated by red arrows) after the first vitrectomy combined with encircling band. (c) Severe inferior proliferation vitreoretinopathy with a new break (red arrows) after the second vitrectomy. (d) Recurrent retinal detachment (red arrows) after the third vitrectomy with silicone oil filled. (e) Left eye showing flattened retina after the use of perfluoro-n-octane as a postoperative tamponade. (f) Left eye in the last follow-up with the well-attached retina

## Discussion

RD is a relatively rare occurrence in the pediatric age group, with an approximate annual incidence of 2.9/10,000 cases.<sup>[11]</sup> The main causes of pediatric RD described in various studies include myopia, trauma, vitreoretinal degeneration, previous ocular surgery, and congenital/developmental anomalies. In Taiwan, myopia has been reported as the leading cause of RD, followed by trauma.<sup>[12]</sup> The anatomical success of RD surgery in pediatric patients is lower than that in adults, ranging from 10% to 80%, depending on the surgical



**Figure 2:** Optical coherence tomography scan comparing the detached retina before the surgery (a) with the well-attached retina and complete resolution of subretinal fluid and intraretinal fluid (b) 1 week after the use of perfluoro-n-octane tamponade postoperatively

approach.<sup>[13,14]</sup> Pediatric RD is characterized by a delay in diagnosis which may affect treatment outcomes, especially in cases with macular detachment or PVR at the time of presentation.<sup>[15]</sup>

PVR is the most common cause of primary RD repair failure. It is characterized by cellular proliferation, release of retinal pigment epithelial cells from a retinal break, and the development of preretinal membranes and subretinal band, ultimately causing contraction, foreshortening, and detachment of the retina. Despite numerous studies evaluating therapeutics, no effective medical therapy currently exists for the treatment or prevention of PVR, and the management remains primarily surgical. Pars plana vitrectomy and membrane-peeling techniques can be utilized to remove both preretinal membrane and subretinal band. Likely due to gravitational effects and the concentration of inflammatory factors inferiorly, in most cases, PVR tends to occur in the inferior quadrants. The incidence of inferior PVR was also lower after postoperative PFO tamponade, probably because of a lack of pooling of the retinal pigment epithelium cells, chemoattractants, and serum components over the inferior retina.<sup>[16]</sup> In addition to the effect of PFO, the long-term retinal reattachment of this case could also be attributed to the completion of PVR process and full elimination of the PVR factors by thorough epiretinal membrane peeling and subretinal band removal.

For severe rhegmatogenous RD associated with PVR, long-acting gas and silicone oil are commonly used for postoperative tamponade. However, their effectiveness is limited when proliferative changes exist in the inferior retina because of their low specific gravity. In this case, gas and silicone oil were ineffective because the posterior proliferative changes were in the inferior retina. Moreover, patients are requested to maintain a prone position for several days to weeks postoperatively when silicone oil or gas tamponade is used. It is difficult to have an active child stay compliant and maintain this position for any length of time. Given the recurrence of the RD and inferior PVR in this child, we decided to use short-term PFO (C8F18) tamponade postoperatively. As PFO has a specific gravity of 1.75, it should be more effective as a tamponade for inferior RD than gas or silicone oil.

PVR continues to be an important cause of recurrent RD in silicone oil-filled eyes, and proliferative membranes occur predominantly in the inferior half of the fundus, as seen in this case. Despite the proven long-term safety profile of silicone oil, it has been reported to release mitogenic factors and thus may be a causative factor in PVR.<sup>[17]</sup> This would then lead to postoperative perisilicone proliferation, which can cause redetachment. Recently, several investigators have reported the use of PFO as a short- and medium-term postoperative

intravitreal tamponade.<sup>[3,6,10,16]</sup> Conversely, PFO appears to release fewer mitogenic factors than silicone oil.<sup>[17]</sup> Theoretically, PFO should be able to lift the proliferative mediators off the retinal surface, thereby preventing the development of PVR.<sup>[3,7]</sup> Another benefit of PFO as a postoperative tamponade is ease of removal, due to its viscosity of 0.58 mm<sup>2</sup>/s, which is lower than that of silicone oil, at 1000–5000 mm<sup>2</sup>/s.

In this case, short-term PFO tamponade was able to stabilize and reattach the inferior retina after 1 week. However, there is a growing literature challenging the notion that PFO should be removed immediately after surgery. The pure PFO is biologically inert and does not contain protonated impurities measurable by nuclear magnetic resonance spectroscopy.<sup>[18]</sup> Imaizumi *et al.*<sup>[5]</sup> reported that PFO was effective and safe as a postoperative tamponade, as long as it is used for a short period only in treating complex pediatric RD. Sisk *et al.*<sup>[19]</sup> successfully reattached the retina in an infant with X-linked retinoschisis and complex RD, with which the PFO was retained in the eye for 25 days without significant inflammation. Sirimaharaj *et al.*<sup>[4]</sup> reported no serious adverse effects of PFO as a postoperative tamponade.

On the other hand, multiple animal studies have shown retinal toxicity when PFO is left in the vitreous cavity as a postoperative tamponading agent. The ocular toxicity of PFO has been ascribed to a combination of chemical and mechanical toxicities. Chang *et al.*<sup>[9]</sup> reported that PFO left for 1 week in rabbit eyes induced mild histologic changes, including thinning of the outer plexiform layer. After 2 weeks, focal areas with narrowing of the outer plexiform layer and ultrastructural distortions of the photoreceptor outer segments in the inferior retina were noted. These changes became more pronounced after 1 and 2 months. Since similar changes have been reported in the superior retina in silicone-filled eyes, these changes may represent mechanical rather than toxic effects.<sup>[9]</sup> Rabbit eyes injected with PFO for 1 and 2 months had minimal lens changes, which consisted of posterior subcapsular opacities in the portions of the lens capsule that came in contact with the PFO.<sup>[4]</sup> On the other hand, rabbit eyes in which the PFO was left in the vitreous cavity for longer than 1 week had varying degrees of globule dispersion.<sup>[9]</sup> Similar findings were noted in all of the eyes in that study at the time of PFO removal. Taken together, the appropriate duration for postoperative PFO tamponade seems to be approximately 1–2 weeks. In this case, in consideration of patient age and retinal toxicity, we removed the PFO 1 week postoperatively, with the retina remaining attached.

The following primary complications associated with PFO tamponade have also been described: cataract



progression, transient intraocular pressure elevation, epiretinal membrane, and foreign body response.<sup>[9,20]</sup> The latter complication is characterized by multiple white precipitates within the indwelling PFO, where PFO was used for inferior RD repair.<sup>[21]</sup> In both instances, granulomatous foreign body response has been attributed to a macrophage-predominant reaction which, unlike true inflammation, does not lead to delayed-type hypersensitivity or structural retinal damage. Our present patient had developed cataract complication and epiretinal membrane after the multiple vitrectomies. In this case, visual recovery was potentially limited by the complexity of the RD and risk of amblyopia.

## Conclusion

In summary, this case demonstrated that PFO appears feasible and tolerable when used as a short-term postoperative tamponade in recurrent pediatric RD with severe PVR. PFO's high specific gravity makes it an ideal tamponading agent, whereas RD is considered to be difficult with conventional gas or silicone oil. We should nonetheless be cautious regarding potential chemical and mechanical retinal injuries via PFO until we know how toxic PFO really is.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient's guardian has given consent for the child's images and other clinical information to be reported in the journal. The patient's guardian understands that the child's name and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

The authors declare that there are no conflicts of interest in this paper.

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