

Perfluorocarbon-perfused Vitrectomy for Severe PDR

This technique, devised by Dr. Quiroz-Mercado, offers an alternative to bimanual surgery, viscodissection, and perfluorodissection.

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Conventional vitreoretinal surgery uses three pars plana sclerotomies.¹ During the procedure vitreous gel is removed and the intraocular volume is replaced for balanced salt solution perfusion.² Perfluorocarbon liquids consist of a hydrocarbon molecule in which hydrogen atoms are replaced by fluorine atoms. Since 1987, Chang et al³ have recommended the use of perfluorocarbon liquid as a surgical tool for the management of complex retinal detachments because of its unique physical and biochemical characteristics. In 1995, Le Mer⁴ reported the use of perfluorocarbon as an adjunct in surgery for severe proliferative diabetic retinopathy (PDR) defined as tractional retinal detachment with or without vitreous hemorrhage. Itoh⁵ described the utility of perfluorocarbon in retinal detachment secondary to diabetic retinopathy as it enabled easy flattening of the posterior retinal folds and effective endophotocoagulation with good visual conditions. Imamura evaluated the value of using perfluorocarbon as adjuvant during vitrectomy in eyes with proliferative diabetic retinopathy. Perfluorocarbon permitted easier flattening of the retina in cases of bullous retinal detachment that developed when a tight vitreoretinal adhesion was loosened; and in cases with combined traction rhegmatogenous retinal detachment, perfluorocarbon was used to tamponade the detached retina which then allowed successful membrane dissection.⁶ Hugo Quiroz-Mercado, MD, described in 2004⁷ and 2005⁸ the perfluorocarbon-perfused vitrectomy as a new technique to remove vitreous in an animal model and during vitrectomy for patients with proliferative diabetic retinopathy and rhegmatogenous retinal

detachment. Experience to date suggests that perfluorocarbon-perfused vitrectomy is a safe and feasible technique for removal vitreous with several advantages over balanced salt solution due to its relative density, immiscibility with blood and ocular fluids, and ability to transport oxygen.

Modifications in vitrectomy instrumentation have attempted to decrease surgical time and reduce intra and postoperative complications so as to provide the best anatomical and functional outcome. We would like to describe Dr. Quiroz-Mercado's perfluorocarbon-perfused vitrectomy original idea in order to treat patients with severe PDR.

DESCRIPTION

The perfluorocarbon-perfused vitrectomy technique consists in pars plana vitrectomy (PPV) performed under continuous infusion of perfluorocarbon. Several changes from the conventional procedure are employed to best exploit perfluorocarbon and achieve all surgical goals.

A standard pars plana sclerotomy is performed. A 4-mm infusion cannula is placed in the inferotemporal quadrant. Infusion is connected to a three-way key. Attachments include perfluorocarbon liquid (Perfluoron, Alcon Laboratories, Inc.) in a 100-cm³ bottle that is height-adjusted to regulate perfusion pressure according to surgeon's preference, balanced salt solution, and air connected to the vitrectomy machine. Using a 20-gauge system, initial vitrectomy is performed in the central vitreous cavity (Figure 1). After all central vitreous is removed, an opening in the posterior vitreous cortex is

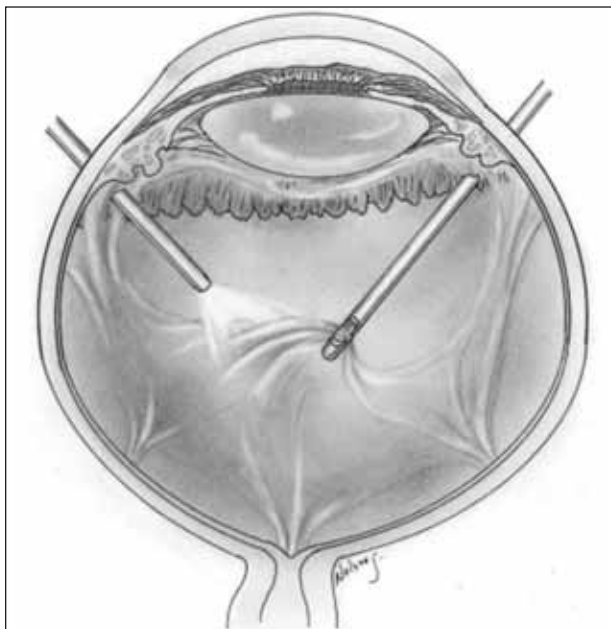


Figure 1. Central core vitrectomy is done under BSS.

made. This opening should be made in the midperiphery, and then a 360° truncation of the posterior vitreous cortex is created. Truncation of the posterior vitreous cortex releases all bonds with the anterior vitreous and permits a safe dissection of fibrovascular tissue in the posterior pole. Then, a hole in the posterior hyaloid is made with a vitreous pick and the infusion is switched to perfluorocarbon (Figure 2). As perfluorocarbon enters the vitreous cavity, it settles to the subhyaloid space and begins to dissect and separate the posterior hyaloid from the retina. Dissection of the fibrovascular proliferations by delamination and segmentation is begun using perfluorocarbon as a surgical tool to dissect and remove fibrovascular proliferations (Figure 3). Perfluorocarbon infusion flattens the detached retina and helps to identify residual traction. Bleeding from the fibrovascular proliferations is contained by perfluorocarbon gravitational force. Due to perfluorocarbon immiscibility with ocular fluids, view remains clear even in the presence of intraocular bleeding. After all traction is released and the retina is reattached, panretinal photocoagulation and careful inspection of the periphery are performed. Hemorrhage is drained and fluid-air exchange performed (Figure 4) followed by injection of gas (SF_6 - C_3F_8) or silicone oil if tears or retinal holes are observed.

DISCUSSION

Precise objectives during PPV for severe PDR are essential. Brevity of the overall procedure is optimal because excessive surgical time may lead to corneal

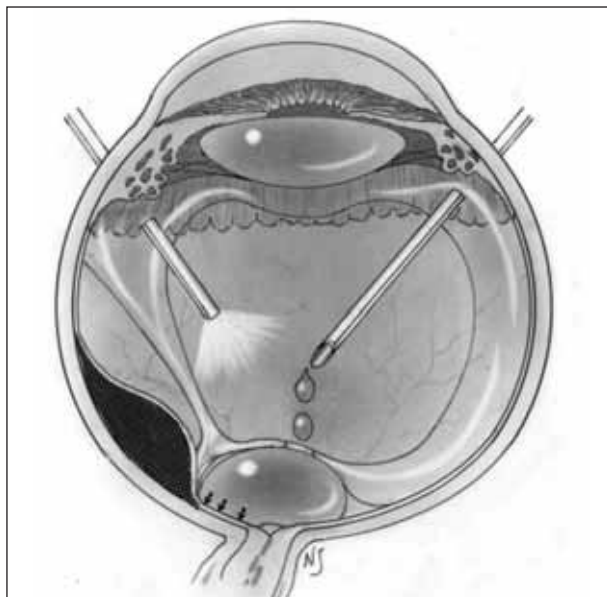


Figure 2. A hole in the posterior hyaloid is made with a vitreous pick and the infusion is switched to PFC. PFC begins to enter the vitreous cavity and goes to the subhyaloid space. PFC flattens the detached retina and is also useful in showing residual traction.

edema and lens opacification with subsequent viewing difficulties and increased chance of complications. Bleeding from fibrovascular proliferations may also impair visualization and preclude panretinal photocoagulation. In cases of combined retinal detachment, increasing the perfusion pressure enhances the risk of corneal edema, damage to the optic nerve, and incarceration of the retina through the sclerotomies. Because fibrovascular membrane dissection under the detached retina makes it movable and unstable, retinotomies are made quite often and if left untreated or with traction, combined retinal detachment will present in the postoperative period.

Dr. Quiroz-Mercado introduced the perfluorocarbon-perfused vitrectomy technique in severe PDR to reduce surgical time, facilitate the procedure, and achieve surgical goals with the fewest intra- and postoperative complications possible. Perfluorocarbon's specific gravity helps stabilize the retina and highlights remaining areas of traction. It also serves as a "third hand," making membrane dissection easier and flattening the retina once traction is eliminated even in the presence of retinal holes. Counter traction in standard balanced salt solution infusion is accomplished by use of a lighted pick or other hand held device which only stabilizes a very small area of retina and may become the site of an inadvertent break as opposed to perfluorocarbon infusion which supports the entire area of

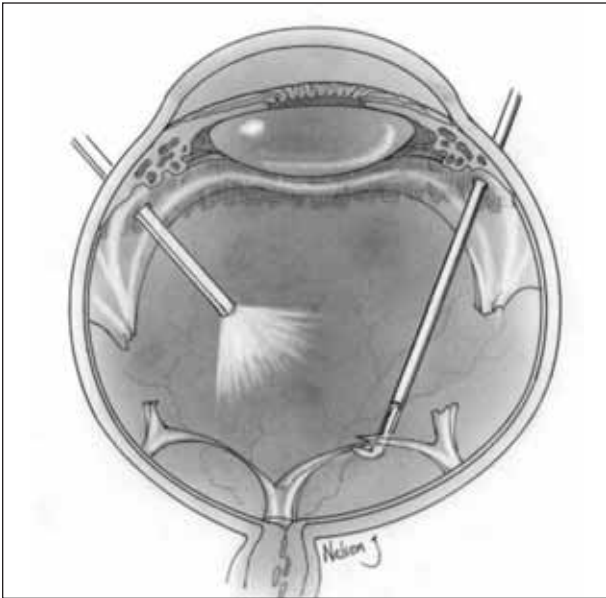


Figure 3. Dissection of fibrovascular proliferations by delamination, and segmentation is begun using PFC as a tool to separate the proliferations and reattach the retina after traction is released.

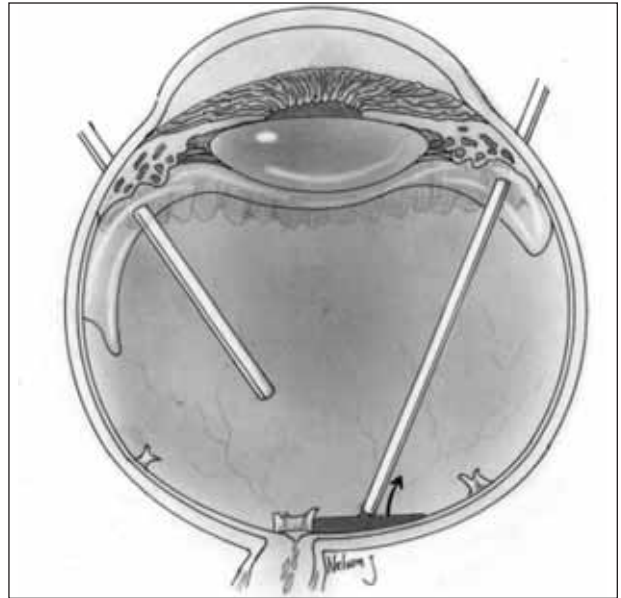


Figure 4. Hemorrhage is drained and fluid-air exchange is performed.

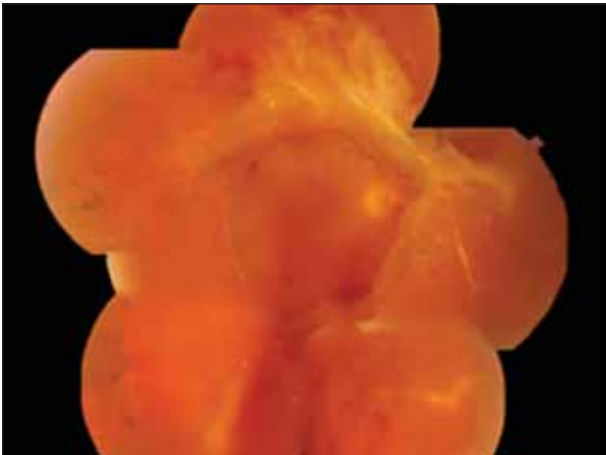


Figure 5. Preoperative clinical condition. Fibrovascular proliferation and traction retinal detachment threatening the macula.



Figure 6. Postoperative clinical condition after 2 months. The retina is completely reattached and traction is released following fibrovascular proliferation segmentation. Panretinal photocoagulation scars outside the vascular arcades.

retina with which it makes contact. Perfluorocarbon's gravitational force and immiscibility with blood and ocular fluids help to control bleeding, providing a good view for panretinal photocoagulation.

Perfluorocarbon has been used as a surgical adjunct in severe PDR. Le Mer⁴ successfully utilized perfluorocarbon to control intraocular hemorrhage during membrane dissection in patients with traction detachments involving or threatening the macula. In this particular series, perfluorocarbon was only used in cases of iatrogenic retinotomies and not as a primary surgical tool to facilitate membrane dissection. Perfluorocarbon infusion can facilitate retinal reattach-

ment in patients with severe PDR and rhegmatogenous retinal detachments with no significant adverse effects.⁸

Dr. Quiroz-Mercado has developed a recycling system in an animal model to decrease the total amount of perfluorocarbon used. The perfluorocarbon was oxygenated, as described by Wilson⁹ to bring high oxygen concentrations. Importantly, oxygenated perfluorocarbon has demonstrated neuroprotective effects on ischemic retina that appear to be related to its capacity to transport and deliver oxygen. Perfusing the vitreous cavity may help the retina from ocular ischemia.

Perfluorocarbon-perfused vitrectomy has been demonstrated to be a safe and feasible technique to perform vitrectomy in patients with rhegmatogenous retinal detachment and PDR.⁶ The properties of perfluorocarbon enable the surgeon to perform shorter vitrectomies with an excellent view, and its use obviates several surgical steps. Because perfluorocarbon is immiscible with ocular fluids, perfluorocarbon-perfused vitrectomy permits large undiluted vitreous samples to be obtained in a safe and effective way.¹⁰

An important caveat is that filling the vitreous cavity with perfluorocarbon may produce unexpected traction over the hyaloid and toward the retina. Therefore, identifying these areas and treating them is critical to avoid intraoperative complications such as retinal tears.

Surgical goals in vitreoretinal surgery for complications of PDR are clearing the media, reattaching the retina, releasing surface traction and performing panretinal photocoagulation. Clearing the media should be done with vitrectomy, following the steps described earlier. Reattaching the retina is performed by releasing anteroposterior and tangential surface traction, and in combined retinal detachments, by draining subretinal fluid and performing fluid-air exchange. In perfluorocarbon-perfused vitrectomy, truncation of the posterior vitreous cortex under balanced salt solution is sufficient to release anteroposterior traction, and segmentation and delamination under perfluorocarbon will release tangential traction (Figures 5 and 6).

Viscodissection and perfluorodissection were introduced^{11,12} with the aim of performing surgery for traction retinal detachment. In both techniques, as well as in perfluorocarbon-perfused vitrectomy, the goal is to separate the posterior hyaloid from the subjacent retina using viscoelastic substances or perfluorocarbon liquids, creating a space suitable for dissection of fibrovascular tissue. The main difference is that in perfluorocarbon-perfused vitrectomy all retina becomes stable as traction is being released. This results in faster dissection of fibrovascular tissue as it will show residual areas of retinal traction, but imposing a significant risk of inadvertent retinal tears due to perfluorocarbon filling the entire vitreous cavity. Another inconvenience of perfluorocarbon-perfused vitrectomy is the lack of intraocular pressure control that can produce damage to the retina and optic nerve, and the costs of using large amounts of perfluorocarbon.

Newer vitrector tips, such as 25+ and 23-gauge, have been designed to have their opening closer to the tip, as well as high speed cutting and duty cycle control will enhance these benefits seen with perfluorocarbon-perfused vitrectomy improving safety and efficiency.

In conclusion, perfluorocarbon-perfused vitrectomy

infusion is an innovative approach to vitrectomy surgery in diabetic patients with several potential advantages over conventional balanced salt solution vitrectomy, and offers an alternative to bimanual surgery, viscodissection, and perfluorodissection. ■

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