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Vitrectomy With Short-Term Perfluorocarbon Liquid Tamponade for Retinal Detachment With Inferior Retinal Breaks and Proliferative Vitreoretinopathy

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Abstract

Purpose: To assess and compare the results of pars plana vitrectomy (PPV) with short-term perfluorocarbon liquid (PFCL) tamponade and combined PPV with scleral buckling to treat rhegmatogenous retinal detachment (RRD) with inferior retinal breaks complicated by proliferative vitreoretinopathy (PVR). **Methods:** The medical records of patients who had vitreoretinal surgery for RRD with inferior retinal breaks complicated by PVR were reviewed. Group 1 had PPV with PFCL, and Group 2 had PPV with scleral buckling. Silicone oil tamponade was used in all cases of PPV with scleral buckling. The anatomic and functional outcomes and duration of surgery were compared between the 2 groups. **Results:** Group 1 comprised 48 eyes and Group 2, 36 eyes. No statistically significant differences were found in the demographic and baseline clinical characteristics between the groups ($P > .05$). The mean ($\pm$SD) duration of the initial surgery was 42.82 $\pm$ 15.25 minutes (range, 25-65) in Group 1 and 81.46 $\pm$ 37.48 minutes (range, 45-115) in Group 2. The difference was significant ($P < .001$). At the end of the follow-up period, recurrent RD occurred in 3 eyes (6.2%) in Group 1 and 2 eyes (5.5%) in Group 2, with no significant difference ($P > .05$). There was no significant difference between the groups in the mean best-corrected visual acuity or mean intraocular pressure at 6 months ($P > .05$). Seven eyes (14.5%) in Group 1 had anterior chamber cells and flares after the initial surgery. The inflammation resolved with topical steroid application. **Conclusions:** The results of PPV with PFCL are similar to those of PPV with scleral buckling for managing RRD with inferior retinal breaks complicated by PVR. Favorable anatomic and functional outcomes are maintained.

Keywords

perfluorocarbon, proliferative vitreoretinopathy, retinal detachment, scleral buckling, vitreoretinal surgery

Introduction

Rhegmatogenous retinal detachment (RRD) is a leading cause of blindness and vision loss. Treatment options include pneumatic retinopexy, scleral buckling, pars plana vitrectomy (PPV), and combination procedures. Overall, the single-surgery success rate is reported to be 90%.[1] RRD with inferior retinal breaks carries a high risk for redetachment because of challenges of postoperative patient positioning, the inadequate effects of lower density tamponades on the inferior retina, missed retinal breaks because of vitreous hemorrhage, and a higher risk for proliferative vitreoretinopathy (PVR).[2,3] PVR results in membrane formation and traction and is a common reason for initial surgical failure and redetachment.[4]

There is an ongoing debate and a lack of consensus regarding the best surgical approach, drainage technique, laser extent, tamponade choice, and postoperative positioning for addressing inferior RRD with PVR.[2,3] Some have noted that a significant success rate can be achieved with the use of combined PPV and scleral buckling with expansile gas and stringent head positioning or with high-density silicone oil (SO). However, this surgical approach is time-consuming and technically challenging for surgeons who have less experience with the technique.[5,6]

An ideal tamponade for managing RD with inferior breaks should have a higher specific gravity than water. Perfluorocarbon liquids (PFCLs) are synthetic compounds in which all

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hydrogen atoms are replaced by fluorine, and their unique physical properties (eg, transparency, low surface tension, low viscosity, and high gravity) make them ideal for intraoperative tamponade during PPV.[7] The gravity of PFCLs typically ranges from 1.76 to 2.30, which is approximately twice as heavy as the perfusion solution.[8] During PPV, PFCLs generate a downward force against the interface when injected into the vitreous cavity, flatten the detached retina, and displace subretinal fluids anteriorly, aiding in the management of RD.

One of the first cases of PFCL use in PPV was in a patient with an RD and advanced PVR, after which many authors described the intraoperative usefulness of this modality in patients with RD and PVR.[9] In such cases, these injections enhance the visualization of proliferative membranes and allow for more thorough removal during the surgical procedure.[9]

Although PFCLs are considered to be biologically inert, their use as a postoperative tamponade over the long term has not been suggested because of the potential for mechanical compression and its disorganized effects on the retina.[10] In addition, there is a growing interest in the use of these liquids for postoperative short-term tamponade because they eliminate the need for postoperative facedown positioning, something that is difficult for many patients to maintain.[11,12] This is an important advantage over traditional tamponades, including SO, sulfur hexafluoride, and perfluoropropane (C_3F_8).

Considering the technical difficulties in performing PPV with scleral buckling as a treatment for RRD with inferior retinal breaks complicated by PVR, an alternative method and a more ideal tamponade are needed. This study compared the outcomes of PPV and PFCL with those of PPV with scleral buckling. The goal was to recommend an alternative form of managing these challenging cases.

Methods

This retrospective case-control study was conducted at a tertiary referral center in Ankara, Turkey. All procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki and approved by the local research ethics committee. All patients provided written informed consent before the surgical intervention.

Inclusion and Exclusion Criteria

The medical records of patients who had vitreoretinal surgery for RRD between 2017 and 2021 were retrospectively reviewed. Patients who fulfilled the following criteria were included in the study: RD with a primary retinal break limited to 4 o'clock to 8 o'clock, grade C PVR, and a minimum follow-up of 6 months after the last ophthalmic surgery. The exclusion criteria included pediatric age; media opacity (eg, corneal opacities, mature cataract, or vitreous hemorrhage); history of other ocular diseases (eg, corneal diseases, glaucoma, age-related macular dystrophy, other retinal dystrophies, diabetic retinopathy [DR], vitreomacular interface abnormalities, or uveitis); history of ocular surgery (excluding phacoemulsification), such as PPV, intravitreal (IVT) pharmacotherapy, or trabeculectomy; strabismus surgery or surgery performed to treat an open-globe injury; and a medical history that included systemic diseases or conditions that can affect the retina, including radiotherapy, corticosteroid use, Behçet disease, or hematologic malignancy.

Short-term IVT tamponade with PFCLs has been used since 2019 at the tertiary referral center. Group 1 comprised patients admitted between 2019 and 2021 who had combined PPV with PFCL and who met the inclusion criteria. Group 2 comprised patients admitted between 2017 and 2019 who had PPV with scleral buckling and who met the inclusion criteria.

Surgical Techniques

Two experienced surgeons (M.C., M.Y.T.) performed all surgical procedures. Retrobulbar 2 mL lidocaine 2% was injected for local anesthesia, and sedation options were available for patients who had excessive anxiety. A standard 25-gauge transconjunctival PPV system (Constellation Vision System, Alcon Laboratories Inc) and a noncontact visualization system (EIBOS 2, Haag-Streit Surgical GmbH) were used. Phacoemulsification and intraocular lens implantation were performed concurrently with vitreoretinal surgery in patients with cataracts. All patients in both groups received topical antibiotics 4 times per day for 2 weeks and topical steroids 4 times per day postoperatively, with gradual tapering for 3 weeks postoperatively.

Pars Plana Vitrectomy With Perfluorocarbon Liquid. In Group 1, triamcinolone acetonide was administered after core vitrectomy. This was followed by posterior hyaloidal membrane removal and vitreous cutting down to the vitreous base. PVR membranes were removed using trypan blue 0.15% (MembraneBlue, DORC). If there was no reattachment, relaxing retinotomy/retinectomy was performed with scissors or a vitrectomy probe, perpendicular to the traction areas. In these cases, retinotomy/retinectomy from the peripheral field was preferred and performed when possible. The retina was then attached with IVT PFCL (F-Decalin, Geuder AG), and endolaser photocoagulation was performed around the retinotomy/retinectomy site and retinal tears. PFCL was used as a postoperative tamponade, completing the first operation. Patients were instructed to remain in a head-upright or reclined position and to avoid face-down positioning. Figure 1 shows a postoperative color fundus photograph and optical coherence tomography image of a patient in Group 1.

A second surgery was scheduled 2 weeks later, and the PFCL tamponade was removed. Additional vitreoretinal surgical procedures (membrane peeling and endolaser) were performed in some cases while the tamponade was being removed. Air, C_3F_8 gas (Teknomek Medical Products), or 5000 cs SO (PDMS 5000, Micromed) tamponade was used at the surgeon's discretion. For patients who had tamponade with 5000 cs SO, the SO was extracted 3 months later.

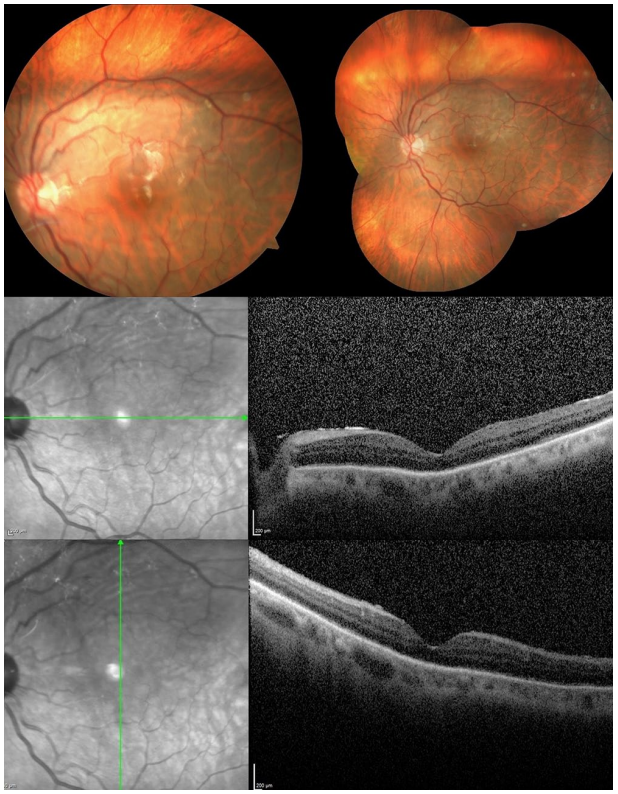

Figure 1. Fundus photographs (top) and optical coherence tomography images (bottom) of a patient's vitreous cavity after perfluorocarbon liquid injection.

Pars Plana Vitrectomy With Scleral Buckling. In Group 2, a partial or 360-degree perilimbal peritomy was performed. Rectus muscles were secured with 4-0 silk sling sutures. Round sponge scleral buckling material (style 504, DORC) was then sutured to the sclera with 5-0 braided polyester coated with polybutylate (Ethibond) using the mattress suture technique to achieve adequate buckling without choroidal folds. The same vitreoretinal surgical procedures were performed, including core vitrectomy, posterior hyaloid membrane removal, vitreous base shaving, PVR removal, retinal reattachment with PFCL, and endolaser photocoagulation. PFCL–air and air–SO (5000 cs) exchanges were performed, and 5000 cs SO was used in all cases as a tamponade. Three months later, a second surgery was performed and the 5000 cs SO was removed.

Clinical Evaluation

Preoperative and postoperative ocular findings as well as the surgical duration were obtained from the medical records. Comprehensive best-corrected visual acuity (BCVA) and intraocular pressure (IOP) examinations were performed preoperatively and 6 months postoperatively. BCVA was evaluated using a Snellen chart, and the data were converted to logMAR notation for statistical analysis. The IOP was measured using pneumotonometry. The anterior segment and posterior segment were examined in detail in all controls. Anterior segment evaluation was performed by slitlamp biomicroscopy. After pupil dilation, an examination of the posterior segment was performed using a 90.0 D magnifying lens. In addition, a Goldmann 3-mirror lens was used to identify retinal breaks and tears.

Table 1. Demographic Characteristics of Group 1 and Group 2.

Characteristic	Group 1	Group 2	*P* Value
Mean patient age (y) ± SD	52.55 ± 11.28	53.52 ± 10.20	.78
Male-to-female ratio	35:11	28:7	.67
Mean number of breaks	2.5	2.4	.92
Mean clock hours of PVR	3.1	3.3	.41
Mean amount of RD clock hours	5.4	5.1	.91
Mean duration of RD by symptomatic history (d)	34	32	.86

Abbreviations: PVR, proliferative vitreoretinopathy; RD, retinal detachment.

Statistical Analysis

Statistical analysis was performed using SPSS software (version 23.0, IBM Corp). The mean ± SD (minimum-maximum) was used to present descriptive statistics. The χ^2 test was used to compare categorical values, and the Kolmogorov-Smirnov test was used to assess the normal distribution of variables. The Wilcoxon test was used to compare dependent variables, and the Mann-Whitney *U* test was used to assess independent variables. Statistical significance was set at $P < .05$.

Results

Group 1 comprised 48 eyes of 46 patients, and Group 2 comprised 36 eyes of 35 patients. The mean age of patients was 52.55 ± 11.28 years (range, 44-72) in Group 1 and 53.52 ± 10.20 years (range, 45-70) in Group 2. The male-to-female ratio was 35:11 and 28:7, respectively. Table 1 shows the demographic characteristics of the cases, including the number of breaks, clock hours of PVR, number of RD clock hours, and duration of RD based on symptomatic history. There were no statistically significant differences between the 2 groups in demographic characteristics (all $P > .05$).

Pathologic myopia, defined as a spherical equivalent greater than −6.00 D and an axial length greater than 26.5 mm, was present in 5 patients (10.4%) in Group 1 and in 3 patients (8.3%) in Group 2. Twenty-four eyes (50%) in Group 1 and 17 eyes (47.2%) in Group 2 were pseudophakic.

The mean BCVA was 1.96 ± 0.41 logMAR (range, 2.30-1.00) in Group 1 and 2.13 ± 0.31 logMAR (range, 2.30-1.30) in Group 2. The mean IOP was 11.28 ± 4.78 mm Hg (range, 4-21) and 11.41 ± 3.52 mm Hg (range, 7-16), respectively. There was no significant between-group difference in any baseline clinical characteristics (all $P > .05$).

In Group 1, 7 eyes (14.5%) had anterior chamber inflammation of more than grade 3+ cells and flare on the third day after the initial surgery. The inflammation resolved within 7 days after the frequency of topical steroid application was increased. No other PFCL-associated complications, such as significant intraocular inflammation (eg, keratic precipitates, membrane formation, or posterior synechiae), topical antiglaucoma agent–resistant IOP elevation, or PFCL bubbles in the anterior chamber, were noted after the first surgery. PFCL extraction was performed 2 weeks later, as previously described.

The mean time between the first surgery and second surgery was 2.64 ± 2.06 weeks (range, 2-3 weeks). Additional vitreoretinal procedures (membrane peeling or laser treatment) were performed in 24 patients (50%) during PFCL removal under staining with trypan blue 0.15%. When the presence of a membrane was detected (new or missed in the previous surgery), membrane peeling was performed. For the postoperative tamponade, air was used in 11 patients (22.9%), C_3F_8 in 18 patients (37.5%), and 5000 cs SO in 19 patients (39.5%). SO removal was performed after a mean of 11.83 ± 4.59 weeks (range, 7-24) in Group 2 patients who had 5000 cs SO tamponade in the second surgery.

A local explant in the inferior quadrant and vitrectomy with SO tamponade were performed in Group 2 in all cases. The mean duration between the first retinal surgery and the second SO removal operation was 13.22 ± 4.17 weeks (range, 10-18).

The mean duration of the first surgery was 42.82 ± 15.25 minutes (range, 25-65) in Group 1 and 81.46 ± 37.48 minutes (range, 45-115) in Group 2. In the second surgery, the mean time to PFCL removal was 21.53 ± 13.26 minutes (range, 15-45) in Group 1 and the mean time to silicone removal was 32.13 ± 10.67 minutes (range, 20-55) in Group 2. The duration of the initial surgery was significantly shorter in Group 1 than in Group 2 ($P < .001$); however, there was no significant between-group difference in the duration of the second surgery ($P > .05$). The mean follow-up time after the final surgery was 14.39 ± 5.39 months (range, 6-27) in Group 1 and 15.01 ± 6.89 months (range, 6-30) in Group 2. The mean follow-up time was not significantly different between the 2 groups ($P > .05$).

During the first surgery, retinotomy/retinectomy was performed in 13 eyes (27%) in Group 1 and in 9 eyes (25%) in Group 2. The difference between the 2 groups was not significant ($P > .05$).

Recurrent RD occurred in 3 eyes (6.2%) in Group 1 and in 2 eyes (5.5%) in Group 2 at the end of the follow-up period; the difference was not significant ($P > .05$). Patients who developed recurrent detachment in Group 1 were those in whom C_3F_8 was the preferred tamponade in the second surgery; no patient with a silicone tamponade developed recurrent detachment. PVR was the cause of recurrent RD in both groups. When cases without retinectomy were compared, there was no difference in the rate of recurrent detachment between the 2 groups.

At 6 months, the mean BCVA was 1.53 ± 0.60 logMAR (range, 2.30-0.70) in Group 1 and 1.70 ± 0.41 logMAR (range, 2.30-1.00) in Group 2. The mean IOP was 15.71 ± 6.21 mm Hg (range, 8-35) and 16.25 ± 7.88 mm Hg (range, 8-35), respectively. There was no significant difference between the groups in the BCVA and IOP in terms of the clinical outcomes ($P > .05$).

Conclusions

RRD with inferior retinal breaks complicated by PVR represents a particular challenge for surgical intervention because unfavorable outcomes after surgery are common. In recent years, many studies have sought to identify the best treatment option for such cases. In a study of various tamponade agents, Schwartz et al[13] found no significant advantages of 5000 cs SO over 1000 cs or 5000 cs SO. In 86 cases of RRD with inferior retinal breaks, Wickham et al[14] found that the primary anatomic success rates were similar between the PPV (gas tamponade) group and PPV with scleral buckling group. In addition, many studies have concluded that RRD with inferior retinal breaks cannot be treated with PPV and gas tamponade because of the reduced support on the inferior retina.[15,16] Baumgarten et al[17] showed that PPV with scleral buckling for RRD with inferior retinal breaks can be beneficial, especially in cases with breaks around the 6 o'clock position.

Although there is no consensus in the vitreoretinal community regarding which method provides better anatomic or functional outcomes, PPV with scleral buckling has been proposed as a treatment option for patients diagnosed with RRD who are at high risk for developing advanced PVR.[18] In our study, the control group comprised patients treated with PPV with scleral buckling, and 5000 cs SO was used as the postoperative tamponade.

In a series of 325 eyes with complex RRD (PVR, trauma, giant retinal tear, proliferative DR, or cytomegalovirus retinitis), Scott et al[19] reported that both anatomic and functional outcomes were comparable when 1000 cs SO and 5000 cs SO were used. In the current study, 5000 cs SO was preferred. However, higher rates of postoperative PVR complications have been reported in patients treated with PPV with scleral buckling than in those treated with PPV alone. This finding underscores the need for a better treatment approach in such cases.[14] For this reason, the treatment in our study group comprised PPV with PFCL. Although numerous studies have reported the outcomes of PFCL use in patients with RRD, ours is a controlled study to propose an alternative treatment for RRD in eyes with inferior retinal breaks and PVR.

Naz et al[20] reported significant visual improvement in complex RRD with inferior retinal breaks after PPV with PFCL, and the retina remained completely attached for at least 6 months in 39 (97.5%) of 40 eyes. Rofail and Lee[11] documented an anatomic success rate of 93.7% in cases of giant retinal tears without a significant PVR. Only 1 patient experienced recurrent RD after PPV with PFCL. Another series of 122 patients reported a high anatomic success rate with combined PPV and PFCL for various causes of RD, such as chronic RD, RD with previously failed surgery, or RD with previously failed surgery.[21] Chehade et al[22] similarly reported a 98.8% retinal reattachment rate at 12 months. They concluded that PPV with PFCL was an effective and safe

technique for managing various types of complex RDs, including cases secondary to giant tears, the presence of PVR grade C, an inferior location, traction, trauma, and redetachment.

In the current study, anatomic success was achieved in 93.8% of patients during a prolonged follow-up period after PPV with PFCL for treatment of RRD with inferior retinal breaks and PVR. This high rate was similar to that of PPV with scleral buckling and showed that the anatomic and functional outcomes were comparable between PPV with PFCL and PPV with scleral buckling, a finding that was among the most important aspects of this study.

Therefore, PPV with PFCL may be an alternative to PPV with scleral buckling and represents a promising practical approach for treating RRD with inferior retinal breaks and PVR without compromising anatomic and functional outcomes. We found that the surgical time for PPV and PFCL was shorter than for PPV with scleral buckling. Less surgical time results in less anesthesia time and a shorter waiting list for surgery. It also increases the comfort of the patient and surgeon. The techniques in this method comprise the conventional stages of PPV, and the duration of surgery and the required surgical effort are no longer than those in conventional PPV. Although some patients who had PPV with PFCL required additional surgery (for patients who received 5000 cs SO in the second surgery), this is acceptable considering the requirements associated with PPV with scleral buckling (peribulbar tissue dissection, extraocular muscle manipulation, buckling materials, and surgical time) and common adverse events (strabismus and implant extrusion).

Intraocular inflammation, persistent IOP elevation, and retinal toxicity are well-known complications of PFCL retention in the vitreous cavity. Sigler et al[23] reported a high rate of intraocular inflammation after PPV with PFCL in their series. They also reported that inflammation spontaneously resolves within 3 weeks after tamponade removal in all cases, or with topical corticosteroid use. Rush et al[24] found a 36% rate of IOP elevation, which is another sight-threatening complication. Considering that some of these cases progressed to filtering surgery, it can be concluded that this method should preserve only complicated cases and prevent routine use.

Morphologic changes and retinal toxicity are other important concerns with PFCL use.[25,26] The clinical significance of the retinal toxicity associated with PFCL has not yet been shown. It is technically difficult to directly discern the retinal toxicity of PFCL with electrophysiologic tests because of primary retinal diseases (RRD). It is known that the rates and severities of complications are directly associated with the duration of PFCL in the vitreous cavity.[27] In the current study, as in many previous studies, the mean PFCL application was limited to 2 to 3 weeks.[11,20,22,23] This duration is considered to be short enough to prevent significant complications and sufficient enough to allow permanent retinal reattachment.[28]

In this study, after the initial surgery, 7 eyes (14.5%) exhibited grade 2 and 3 flare and anterior chamber inflammation. These symptoms resolved when the frequency of topical steroid use increased. On the other hand, no other significant adverse effects directly attributable to PFCL were observed, and similar results have been reported.[11,29]

Heavy SO, which is a mixture of hydrocarbonated olefin and perfluorohexyloctane with SO, is used in inferior half tears and detachments.[30] The density of the routinely used SO is 0.96 g/mL, and the force applied to the upper retinal surface is higher. In heavy SO, the density is 1.02 to 1.06 g/mL; because it is heavier than water, it has been used in cases of inferior half tamponades and posterior tears.[30] The most important advantages of these oils are that they provide a good tamponade in the inferior retinal quadrants where the risk for PVR is high and relaxing retinotomies are frequently performed. In addition, they do not require prone positioning of the patient and can be left in the eye for up to 3 months without causing retinal toxicity.[30]

Wolf et al[31] reported that anatomic success was achieved with 1 operation in 82% of their patients with RD using heavy SO, whereas 18% required a second operation for a superior RD. Rizzo et al[32] obtained an anatomic success rate of 53.5% with heavy SO in their study, which included patients with RD. Anatomic success was particularly low in patients with previous scleral buckling and in 84.6% of the patients without scleral buckling. The reason for the failure in cases of scleral buckling was interpreted as the low affinity of the heavy SO to the retinal surface and its inability to adapt to surface shape changes caused by indentation, leading to potential gaps. It has been argued that this causes epiretinal proliferation and recurrent RD.

The retrospective nature of the study can be considered a limitation because important data may have been missing from follow-up records. The relatively small number of cases is an additional limitation. Similarly, because the study location was a tertiary referral center and many patients came from other cities, it is possible that the results were obtained from more delayed and difficult surgical cases. In this study, patients were sequentially assigned to 2 groups. Although the same surgeons performed the combined surgery between 2017 and 2019, short-term PFCL tamponade was performed between 2019 and 2021 and the results of these 2 surgeries were compared.

In conclusion, this study was designed to recommend an alternative treatment for challenging vitreoretinal surgery. Compared with similar studies, the primary strength of this study lies in the incorporation of a control group, PPV with scleral buckling, which is a recommended treatment option for addressing RRD with inferior retinal breaks and PVR. Both groups consisted of demographically and clinically similar cases. To anticipate medium-term or long-term outcomes, only cases with at least 6 months of follow-up were considered for study inclusion. These results indicate that PPV with PFCL tamponade has results similar to those of PPV with scleral buckling for managing RRD with inferior retinal breaks and PVR without sacrificing anatomic and functional results.

Ethical Approval

All procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki and approved by the local research ethics committee.

Statement of Informed Consent

All patients provided written informed consent before the surgical intervention.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

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References

1. Sharma A, Grigoropoulos V, Williamson TH. Management of primary rhegmatogenous retinal detachment with inferior breaks. *Br J Ophthalmol*. 2004;88(11):1372-1375. doi:10.1136/bjo.2003.041350
2. Arjmand P, Felfeli T, Mandelcorn ED. Combined pars plana vitrectomy and segmental scleral buckle for rhegmatogenous retinal detachment with inferior retinal breaks. *Clin Ophthalmol*. 2021;15:3515-3519. doi:10.2147/OPTH.S321371
3. Storey P, Alshareef R, Khuthaila M, et al. Pars plana vitrectomy and scleral buckle versus pars plana vitrectomy alone for patients with rhegmatogenous retinal detachment at high risk for proliferative vitreoretinopathy. *Retina*. 2014;34(10):1945-1951. doi:10.1097/IAE.0000000000000216
4. Hooymans JM, De Lavalette VW, Oey AG. Formation of proliferative vitreoretinopathy in primary rhegmatogenous retinal detachment. *Doc Ophthalmol*. 2000;100(1):39-42. doi:10.1023/a:1002428928803
5. Alexander P, Ang A, Poulson A, Snead MP. Scleral buckling combined with vitrectomy for the management of rhegmatogenous retinal detachment associated with inferior retinal breaks. *Eye (Lond)*. 2008;22(2):200-203. doi:10.1038/sj.eye.6702555
6. Hostovsky A, Yap J, Mandelcorn MS, Mandelcorn ED. Densiron 68 heavy silicone oil as a short-term intraocular tamponade for maculaon inferior retinal detachments—a case series. *Retin Cases Brief Rep*. 2022;16(5):581-585. doi:10.1097/ICB.0000000000001037
7. Yu Q, Liu K, Su L, Xia X, Xu X. Perfluorocarbon liquid: its application in vitreoretinal surgery and related ocular inflammation. *Biomed Res Int*. 2014;2014:250323. doi:10.1155/2014/250323
8. Sparrow JR, Jayakumar A, Berrocal M, Ozmert E, Chang S. Experimental studies of the combined use of vitreous substitutes of high and low specific gravity. *Retina*. 1992;12(2):134-140. doi:10.1097/00006982-199212020-00010
9. Coll GE, Chang S, Sun J, Wieland MR, Berrocal MH. Perfluorocarbon liquid in the management of retinal detachment with proliferativevitreoretinopathy. *Ophthalmology*. 1995;102(4):630-639. doi:10.1016/s0161-6420(95)30975-x
10. Chang S, Sparrow JR, Iwamoto T, Gershbein A, Ross R, Ortiz R. Experimental studies of tolerance to intravitreal perfluoro-n-octane liquid. *Retina*. 1991;11(4):367-374.
11. Rofail M, Lee LR. Perfluoro-n-octane as a postoperative vitreoretinal tamponade in the management of giant retinal tears. *Retina*. 2005;25(7):897-901. doi:10.1097/00006982-200510000-00013
12. Sirimaharaj M, Balachandran C, Chan WC, et al. Vitrectomy with short term postoperative tamponade using perfluorocarbon liquid for giant retinal tears. *Br J Ophthalmol*. 2005;89(9):1176-1179. doi:10.1136/bjo.2004.065409
13. Schwartz SG, Flynn HW Jr, Wang X, Kuriyan AE, Abariga SA, Lee WH. Tamponade in surgery for retinal detachment associated with proliferative vitreoretinopathy. *Cochrane Database Syst Rev*. 2020;5(5):CD006126. doi:10.1002/14651858.CD006126.pub4
14. Wickham L, Connor M, Aylward GW. Vitrectomy and gas for inferior break retinal detachments: are the results comparable to vitrectomy, gas, and scleral buckle? *Br J Ophthalmol*. 2004;88(11):1376-1379. doi:10.1136/bjo.2004.043687
15. Goto T, Nakagomi T, Iijima H. A comparison of the anatomic successes of primary vitrectomy for rhegmatogenous retinal detachment with superior and inferior breaks. *Acta Ophthalmol*. 2013;91(6):552-556. doi:10.1111/j.1755-3768.2012.02455.x
16. Heussen N, Feltgen N, Walter P, et al. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment study (SPR Study): predictive factors for functional outcome. Study report no. 6. *Graefes Arch Clin Exp Ophthalmol*. 2011;249(8):1129-1136. doi:10.1007/s00417-011-1619-7
17. Baumgarten S, Schiller P, Hellmich M, et al. Vitrectomy with and without encircling band for pseudophakic retinal detachment with inferior breaks: VIPER Study Report No. 3. *Graefes Arch Clin Exp Ophthalmol*. 2018;256(11):2069-2073. doi:10.1007/s00417-018-4106-6
18. Echegaray JJ, Vanner EA, Zhang L, et al. Outcomes of pars plana vitrectomy alone versus combined scleral buckling plus pars plana vitrectomy for primary retinal detachment. *Ophthalmol Retina*. 2021;5(2):169-175. doi:10.1016/j.oret.2020.09.013
19. Scott IU, Flynn HW Jr, Murray TG, Smiddy WE, Davis JL, Feuer WJ. Outcomes of complex retinal detachment repair using 1000- vs 5000-centistoke silicone oil. *Arch Ophthalmol*. 2005;123(4):473-478. doi:10.1001/archopht.123.4.473
20. Naz S, Naz U, Fahad HM, Rizvi SF. Outcomes of using perfluorocarbon liquid as postoperative tamponade in complex inferior retinal detachments. *J Coll Physicians Surg Pak*. 2022;32(11):1454-1458. doi:10.29271/jcpsp.2022.11.1454
21. Bhurayanontachai P, Seepongphun U. Outcomes of a postoperative perfluorocarbon liquid tamponade for complex retinal detachments: 12 years of experience in southern Thailand. *BMC Ophthalmol*. 2020;20(1):358. doi:10.1186/s12886-020-01600-z
22. Chehade LK, Guo B, Chan W, Gilhotra J. Medium-term tamponade with vitrectomy and perfluorodecalin for the management of complex retinal detachments. *Eur J Ophthalmol*. 2021;31(5):2625-2630. doi:10.1177/1120672120945108
23. Sigler EJ, Randolph JC, Calzada JI, Charles S. Pars plana vitrectomy with medium-term postoperative perfluoro-N-octane for recurrent inferior retinal detachment complicated by advanced proliferative vitreoretinopathy. *Retina*. 2013;33(4):791-797. doi:10.1097/IAE.0b013e31826a6978

24. Rush R, Sheth S, Surka S, Ho I, Gregory-Roberts J. Postoperative perfluoro-n-octane tamponade for primary retinal detachment repair. *Retina*. 2012;32(6):1114-1120. doi:10.1097/IAE.0b013e31822f56f6
25. Elsing SH, Fekrat S, Green WR, Chang S, Wajer SD, Haller JA. Clinicopathologic findings in eyes with retained perfluoro-n-octane liquid. *Ophthalmology*. 2001;108(1):45-48. doi:10.1016/s0161-6420(00)00481-4
26. Singh J, Ramaesh K, Wharton SB, Cormack G, Chawla HB. Perfluorodecalin-induced intravitreal inflammation. *Retina*. 2001;21(3):247-251. doi:10.1097/00006982-200106000-00009
27. Sigler EJ, Randolph JC, Charles S. Foreign body response within postoperative perfluoro-n-octane for retinal detachment repair: clinical features, grading system, and histopathology. *Retina*. 2014;34(2):237-246. doi:10.1097/IAE.0b013e31829d002e
28. Kita M, Negi A, Kawano S, Honda Y. Photothermal, cryogenic, and diathermic effects of retinal adhesive force in vivo. *Retina*. 1991;11(4):441-444. doi:10.1097/00006982-199111040-00015
29. Ventura MC, Melo C, Escarião P, Diniz JR, Leão AC. Perfluoroctano líquido como tamponante vitreorretiniano de curta duração no pós-operatório de portadores de descolamento de retina por ruptura gigante [Perfluoroctane liquid as a short-term vitreous-retinal tamponade in the postoperative period in patients with retinal detachment due to giant tears]. *Arq Bras Oftalmol*. 2007;70(3):495-500. doi:10.1590/s0004-27492007000300018
30. Ilhan C, Citirik M. Silicone oils and their properties used in rhegmatogenous retinal detachment surgery. *Curr Retina (Güncel Retina)*. 2019;3(3):176-180. doi:10.37783/CRJ-0161
31. Wolf S, Schön V, Meier P, Wiedemann P. Silicone oil-RMN3 mixture ("heavy silicone oil") as internal tamponade for complicated retinal detachment. *Retina*. 2003;23(3):335-342. doi:10.1097/00006982-200306000-00008
32. Rizzo S, Genovesi-Ebert F, Belting C, Vento A, Cresti F. A pilot study on the use of silicone oil-RMN3 as heavier-than-water endotamponade agent. *Graefes Arch Clin Exp Ophthalmol*. 2005;243(11):1153-1157. doi:10.1007/s00417-005-0015-6