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Research Article

The Rate of Sub-Retinal Perfluorocarbon Liquid Retention with Dry-Out Technique

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ABSTRACT

Purpose: The aim of this study is to establish if the 23-gauge dry out Pars Plana Vitrectomy (PPV) can be considered as a safe and efficient technique to prevent sub-retinal Perfluorocarbon Liquid (PFCL) migration in primary Rhematogeneous Retinal Detachment (RRD) repair.

Methods: A retrospective, consecutive interventional case series of 230 patients (236 eyes) who underwent a 23-gauge dry-out PPV with PFCL for primary RRD repair from January 2014 till March 2020 were analyzed. The main outcome measure was the absence of sub-retinal PFCL and the anatomical reattached retina for at least 3 months postoperatively.

Results: A total of 236 primary RRD repairs were performed by one surgeon (EB). The main success rate (reattached retina up to 3 months post-operatively) was 85.6% (202/236). Sub-retinal PFCL occurred in 1/236 eyes.

Conclusion: 23-gauge dry-out PPV seems to be a safe and effective technique with good anatomical reattachment rate in the treatment of primary RRD. Our study shows encouraging results of preventing PFCL migrating in to the sub-retinal space with the dry-out 23-gauge PPV.

Keywords: Pars Plana Vitrectomy (PPV); Perfluorocarbon liquid; Sub-retinal; Interfacial; Rhematogeneous Retinal Detachment (RRD)

INTRODUCTION

Pars Plana Vitrectomy (PPV) has gained popularity during the past few decades and is presently the gold standard for treating primary Rhematogeneous Retinal Detachment (RRD). Perfluorocarbon Liquid (PFCL) has become an indispensable tool in PPV, especially in retinal detachment treatment since its first use by Chang [1]. Important characteristics of PFCL include high specific gravity, low viscosity, and optical clarity, refractive index that differs from that of saline, boiling point that is higher than that of water, low surface tension, high interfacial tension, and immiscibility with silicone oil, water, and blood [2]. PFCL provides displacement of sub-retinal fluid, eliminates the need for a posterior drainage retinotomy, minimize macular distortion or folds and prevents slippage of large retinectomy edges [3].

Sub-retinal PFCL retention is the most important and a well-described complication following its use [4]. Small quantities of sub-retinal PFCL outside of the macula are often well tolerated, but long-term sub-foveal PFCL can cause irreversible vision loss due to retinal degeneration, gravity deformation, barrier effects, retinal pigment epithelium and photoreceptor toxicity which can induce irreversible glial proliferation, retinal damage and vision loss [5,6]. Although sub-retinal PFCL droplet has occasionally been shown to migrate spontaneously, it often remains constant in size and position for a long period [6]. Spontaneous resolution of sub-foveal PFCL was observed recently. It is hypothesized that the PFCL droplet extruded through a transient retinal hole due to the thinning of retina above the droplet and then closed spontaneously [7,8]. It has also been reported that persistent sub-foveal PFCL can cause retinal holes [7]. Optical Coherence Tomography (OCT) has become the golden standard to diagnose any sub-retinal PFCL droplets due to their characteristic features that can be distinguished from residual sub-retinal fluid or macular cyst [4]. The aim of this study is to establish if the 23-gauge dry out Pars Plana Vitrectomy (PPV) can be considered as a safe

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and efficient technique to prevent sub-retinal Perfluorocarbon Liquid (PFCL) migration in primary Rhematogeneous Retinal Detachment (RRD) repair.

MATERIALS AND METHODS

A retrospective, consecutive interventional study of 230 patients (236 eyes) who underwent a 23- gauge dry-out PPV with PFCL for primary RRD repair from January 2014 till March 2020 was carried out. The main outcome measure was the anatomical reattached retina for at least 3 months postoperatively and the absence of sub-retinal PFCL. All patients were operated by one surgeon (EB) at the Department of Ophthalmology at the Delta Hospital (Group CHIREC), Brussels. The data recorded included patient age, gender, pre-operative macula status, extent of retinal detachment in quadrants, number and location of retinal breaks, tamponade agent, Spectral Domain Optical Coherence Tomography (SD-OCT), presence of sub-retinal PFCL and recurrence of retinal detachment. All statistical analyses were performed with Statistical Analysis System for Excel Windows version 9.1.3 (SAS Inc., Cary, NC, USA). Patients older than 18 with at least three months of follow-up and those with primary RRD who did not have Proliferative Vitreous Retinopathy (PVR) were eligible for inclusion. Traumatic Retinal Detachment (RD), prior ocular trauma or chronic inflammation, previous RD surgery, all PVR cases and RD in association with diabetic retinopathy or macular hole were excluded.

The surgical procedure is briefly as follows. Most patients received retro-bulbar anesthesia (4-5 mL Lidocaine 2%) before their PPV procedures, however some also underwent general anesthesia. All patients were treated using the dry out method. This procedure takes between 40 minutes and 1 hour, involves a three-port suture less Pars Plana Vitrectomy (PPV) utilizing valved trocars positioned 3 mm to 4 mm from the limbus depending on the patient's lens condition. A core vitrectomy was carried out once the posterior hyaloid face separation was verified or induced. To stabilize/flatten the posterior retinal pole, Perfluorocarbon Liquid (PFCL-Decaline® 7 mL, FCI Sas, France) was instilled slowly using a Charles's flute cannula. The flow of infusion was stopped during the injection to prevent turbulence at the interface PFCL and saline solution. The meniscus of the PFCL was always maintained below the level of the most posteriorly situated tear to prevent sub-retinal migration.

Peripheral vitreous was then thoroughly shaved using scleral indentation and a disposable retractable chandelier light 23-gauge (Bausch+Lomb®, USA). No additional PFCL was instilled till the level of the ora serrata to flatten the retina. After performing the periphery vitrectomy, partial air-fluid exchange was carried out by using a Charles' flute cannula. Sub-retinal Fluid (SRF) was drained through the preexisting retinal tears. A complete air-fluid was then carried out with removal of remaining PFCL.

Application of laser retinopexy around the breaks and/or on 360° on the peripheral retina was then applied using a 23-gauge curved laser probe (Bausch+Lomb®, USA) in an air-filled globe. Intra ocular tamponade with air or Sulphur Hexafluoride 20% (SF6) was used as tamponade agent. Patients were followed at 1 day, 1 week, 1 month, and 3 months postoperatively. During these post-operative visits, patients were examined for reattachment of the retina, using slit lamp biomicroscopy and indirect ophthalmoscopy. Patients were also examined for the development of post-operative complications, such as the presence sub-retinal PFCL with SD-OCT (Table 1).

Table 1: Patients with pre-operative characteristics.

Variables	Data (N)
Age (mean ± SD)	60.3 ±10.9 years (236)
Gender (male/female)	157/79 (236)
Right/left eye	126/108 (236)
Macula on/off	145/86 (231)
Number of retinal breaks (mean ± SD)	1.7 ± 0.9 (231)
Only superior breaks (9 till 3 o'clock)	132 eyes, 57.1% (231)
Only inferior breaks (4 till 8 o'clock)	45 eyes, 19.5% (231)
Concomitant superior and inferior breaks	55 eyes, 23.8% (231)
Giant breaks (≥ 3 o'clock hour)	3 eyes, 1.3% (231)
Subtotal and total RD	13 eyes, 6% (233)

Note: SD: Standard Deviation; RD: Retinal Detachment

RESULTS

This study included 236 eyes from 230 patients (157 males, 66.8%), aged 60.4 ± 10.9 years. Five of the 236 eyes did not have a thorough description of the breaks and were not included in the statistical analysis. The mean number of retinal breaks (including horseshoe tears and round retinal holes discovered post-operatively) was 1.7 ± 0.9. 132/231 patients (57.1%) had only superior breaks (defined as breaks between 9 o'clock and 3 o'clock), 45 patients (19.5%) had only inferior breaks, and 55 patients (23.8%) had both superior and inferior breaks. Giant tears, which are tears that extend 3 o'clock hours, were detected in 3 cases. 13 eyes had a partial or full RRD.

The main success rate (reattached retina up to 3 months post-operatively) was 85.6% (202/236) for the 236 eyes that had 23 gauge dry-out PPV for primary RRD repair. Most of the patients received an air tamponade (165/236) and the rest received SF6 tamponade (71/236). There were 15 patients who developed post-operative PVR and 9 patients who developed new retinal tears in the postoperative follow up. There was 1 case (1/231) who was diagnosed with sub-retinal PFCL diagnosed 1 month post operatively with SD-OCT (Table 2).

Table 2: Statistical analysis of success rate over years in patients.

Years	Tamponade	SL28
2014	33.3% (8/24) air 66.7% (16/24) SF6	87.5% (7/8) 87.5% (14/16)
2015	51.3% (20/39) air 48.7% (19/39) SF6	85% (17/20) 78.9% (15/19)
2016	58.8% (20/34) air 41.2% (14/34) SF6	85% (17/20) 64.3% (9/14)
2017	80% (28/35) air 20% (7/35) SF6	96.3% (27/28) 71.4% (5/7)
2018	73.6% (39/53) air 26.4% (14/53) SF6	82.1% (32/39) 92.9% (13/14)
2019	97.7% (45/46) air 2.2% (1/46) SF6	91.3% (42/46) 100% (1/1)
2020	100% (5/5) air 0% (0/5) SF6	80% (4/5) 0% (0/5)
Overall	69.9% (165/236) air 30.1% (71/236) SF6	88.5% (146/165) 80.3% (57/71)

Note: SF: Sulphur Hexafluoride

DISCUSSION

The primary success rate for the treatment of primary RRD ranges globally from 76.8% up to 90% due to several advances (development of narrow gauge instruments, improved knowledge of fluidics) The release of all vitreous traction on the retina, by completely shaving the vitreous base and the area around the tears, as an optimal drainage of sub-retinal fluid is crucial for the success of a PPV for RRD repair [9,10]. Since some PPV techniques use posterior retinotomy to drain sub-retinal fluid which might result in a localized proliferative vitreous retinopathy [11] we prefer our dry-out PPV procedure. This study demonstrates that similar primary success rate can be obtained using the dry-out technique. The reported rate of sub-retinal PFCL retention varies between 1 to 11.1% and may not be detected until follow-up visits. Garg and Theventhiran compared the incidence of retained sub-retinal PFCL in 234 patients who had suture less 23-G vitrectomy *vs.* conventional 20-G vitrectomy for the treatment of RRD. With sutured 20-G vitrectomy, subretinal PFCL occurred in 4 out of 176 eyes (2.3%) and in 6 out of 58 eyes (10.3%) with suture less 23-G vitrectomy. The higher fluid flow through open 23-G cannulas, which results in disruption of the PFCL surface tension and the formation of small PFCL bubbles that can enter the sub-retinal space, is attributed by the authors to the 4.5-fold higher incidence of retained sub- retinal PFCL in patients undergoing suture less 23-G vitrectomy compared to traditional 20-G vitrectomy [9].

Garcia-Valenzuela et al. analyzed retrospectively factors that may lead to inadvertent sub-retinal PFCL retention in 72 vitreoretinal surgeries for different indications. Sub-retinal PFCL was found in 8 (11.1%) eyes post-operatively. The occurrence and extent of a peripheral retinotomy, particularly if 360 degrees, was the factor most strongly linked with sub-retinal retention of PFCL [12]. Our study demonstrates only one case of sub-retinal retained PFCL out of 236 operated eyes. There are several possible reasons for these findings. Valved cannulas help to maintain a closed system in the eye, minimizing variation in fluidics and thus reducing the chance of dispersion and bubbling of PFCL. Small fish-egg bubbles of PFCL can easily migrate into the sub-retinal space through retinal breaks. Our concept is to prevent the formation of small bubbles of PFCL by injection the liquid slowly and by submerging the tip of the cannula in the formed bubble to make one big PFCL bubble. We started injecting PFCL over the optic nerve, moving nasally as the bubble enlarges.

The flow of infusion was also stopped during the injection to prevent turbulence at the interface PFCL and saline solution which can cause formation of small bubbles .The meniscus of the PFCL was always maintained below the level of the most posteriorly situated tear to avoid sub-retinal migration. Scleral depression may lead PFCL sometimes to reach the retinal tear and may cause sub-retinal migration. We always try to release the scleral depression slowly to avoid a rapid velocity of infusion. No additional PFCL injection to the level of the ora serrata was carried out even after shaving in order to push away sub-retinal fluid. Filling the eye with PFCL could lead inadvertently in sub-retinal migration, especially if the vitreous tractions on the retina have not been completely released. We prefer draining the sub-retinal fluid through the pre-existing retinal tears by partial air-fluid exchange using a Charles' flute cannula [13]. We start removing the balanced salt solution anterior to the PFCL and then drain Sub-retinal Fluid (SRF) over the pre-existing retinal tear. The rest of the PFCL is removed from over the optic nerve by completing the PFCL-air exchange.

CONCLUSION

The dry-out PPV contains multiple strategies to reduce incidence of sub-retinal perfluorocarbon liquid migration including valved cannulas to inject PFCL as one bubble, prevent turbulence by stopping the infusion during PFCL injection, keeping the PFCL meniscus below the level of the most posteriorly situated tear, and drain SRF over the pre-existing retinal tear. There are several limitations of this study. Because of the retrospective nature some cases of retained sub-retinal PFCL may have been missed on examination. In conclusion, this study demonstrates that 23-gauge dry-out PPV seems to be a safe and effective technique with good anatomical reattachment rate in the treatment of primary RRD. Our study shows encouraging results of preventing PFCL migrating in to the sub-retinal space.

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