Gas Tamponade Followed by Laser Treatment for Macular Retinal Detachment Secondary to Optic Pit

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**Running tittle:** perfluoropropane and laser for optic disc pit-associated maculopathy   
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**Abstract**

Purpose: To describe anatomic and visual outcomes associated with intravitreal injection of perfluoropropane (C3F8) followed by laser treatment for macular retinal detachment secondary to optic disc pit (ODP).

Methods: A single center, retrospective study. Medical records were reviewed of all patients treated at a tertiary retina referral center between 2011 and 2018 for congenital optic disc pit (ODP)-associated macular detachment with intravitreal injection of 100% C3F8 followed by retinal photocoagulation along the temporal margin of the optic disc as the initial treatment strategy for the ODP-associated macular detachment.

Results: Six patients with ODP-associated macular detachment during the study period were identified, with postoperative follow-up ranging from 4 to 52 months. Spectral domain optical coherence tomography (SD-OCT) demonstrated complete resolution of fluid in two cases, with no recurrence after 26 and 100 weeks of follow-up. No additional procedures were performed in either case. Partial fluid reabsorption occurred in the remaining 4 cases. One patient demonstrated no anatomic improvement and was treated with pars plana vitrectomy. Best-corrected visual acuity (BCVA) improved after surgery, considering the last follow-up visit of each case.

Conclusion: Intravitreal injection of 100% C3F8 followed by photocoagulation along the temporal margin of the optic disc margin was associated with anatomic and visual improvement in most cases, and represents an alternative therapeutic approach for ODP-associated macular detachment.

**INTRODUCTION**

Optic disc pit was first reported in 1882 by Wiethe (1). Optic disc pits (ODP) are part of a set of cavitary optic disc anomalies that includes coloboma, morning glory disc and extrapapillary cavitation (2), conditions in which there is abnormal communication between the intraocular and extraocular spaces. ODP are extremely rare, with no gender predilection, and may be congenital or acquired. The estimated incidence of the congenital form is 1:11,000 persons. Only 15% of these patients are affected bilaterally and, in most cases, there is only one pit per disc, with the pit typically located inferotemporally (3). The pits are oval-shaped depressions frequently grey in color, but may be yellowish or black (2,3).

Macular involvement was first described in 1927 by Halbertsma (4). ODP are classically asymptomatic, although up to 75% of affected patients develop retinal detachment or macular retinoschisis, experiencing decreased vision, and the disease is then called optic disc pit maculopathy (3,5).

The pathophysiology of ODP-associated retinal detachment and the origin of the subretinal fluid are controversial, with two sources having been proposed for the latter, i.e., vitreous cavity and subarachnoid space (2,3). Biochemical analysis of the subretinal fluid of two patients showed a composition similar to that of cerebrospinal fluid (6). In contrast to the theory proposed by Lincoff (7) which describes the presence of retinal schisis preceding subretinal fluid accumulation, optic coherence tomography (OCT) studies have demonstrated that retinal schisis is not always present in patients with ODP-associated retinal detachment (8).

The prognosis of untreated ODP-associated macular detachment is guarded. Brown et al (9) followed, for more than one year, 20 eyes with untreated optic disc maculopathy. The authors observed persistence of subretinal fluid in 75% of these cases and last follow-up visual acuity of 20/100 or worse in 55%. Sobol et al (10) followed 15 eyes with ODP-associated with macular detachment for 9 years, and observed that 80% of them had a visual acuity at last follow-up of 20/200 or worse.

There is no universally accepted effective treatment for ODP-associated macular detachment. Various treatments have been described, such as intraocular gas injection only (11), gas injection in combination with laser along the temporal margin of the disc (12), macular buckling (13), pars plana vitrectomy with gas tamponade with or without laser, pars plana vitrectomy with internal limiting membrane peeling with or without a flap (14), infusion of platelet-rich autologous serum (14,15), autologous scleral plug (16), and partial inner retinal fenestration (17).

Herein we report the results of a minimally invasive and low-cost treatment consisting of a combination of intravitreal injection of 100% perfluorpropane (C3F8) followed by retinal photocoagulation along the temporal margin of the optic disc as the initial treatment strategy for ODP-associated macular detachment.

**METHODS**

Medical records were reviewed of all patients treated in a tertiary center between 2011 and 2018 for congenital ODP-associated macular detachment with intravitreal injection of 100% C3F8 followed by retinal photocoagulation along the temporal margin of the optic disc as the initial treatment for their ODP-associated macular detachment.

Data collected include age at diagnosis, gender, laterality, duration of symptoms, visual acuity on presentation, retinal layers affected on OCT scans, time between intraocular gas injection and retinal photocoagulation, need for retreatment or alternative therapeutic approaches, visual acuity at last follow-up, time course of visual acuity improvement, and follow-up duration. The initial treatment was provided by the same surgeon in an ambulatory surgical environment under aseptic conditions and with topical anesthesia. After paracentesis of the anterior chamber, 0.3 ml 100% C3F8 was injected intravitreally and the patient was instructed to maintain face-down positioning for seven days. Retinal photocoagulation with green diode laser was performed along the temporal margin of the optic disc three days after C3F8 injection using the following parameters: 50 to 100 µm spot size with an exposure duration of 50 to 100 milliseconds and sufficient intensity to achieve visible marks. All patients were treated with 360-degree peripheral retinal photocoagulation before C3F8 injection for retinal detachment prophylaxis.

Green diode retinal photocoagulation along the temporal rim of the optic disc was repeated in five patients 30 to 70 days after the first laser session. The laser was repeated once the surgeon observed no improvement of the intra retinal and/or subretinal fluid on OCT follow-up. The mean number of laser sessions was 2.2, with a mean number of 53 spots.

**RESULTS**

Six patients with ODP-associated macular detachment during the study period were identified (Table 1); all of these ODP were congenital. Three patients were males and one had bilateral involvement but consented with treatment only for his left eye. Mean age at diagnosis was 24.3 years (SD=20.76) and duration of symptoms ranged from eight days to five years. Mean best-corrected visual acuity (BCVA) at four meters was 20/200 or worse in three cases and 20/40 or better in two.

Spectral domain optical coherence tomography (SD-OCT) (Spectralis OCT®, Heidelberg Engineering, Heidelberg, Germany) revealed the defect of the optic disc and the presence of macular subretinal fluid in all patients. Four patients had intraretinal fluid involving primarily the outer nuclear layer. In three cases there was fluid in the inner and outer retina. Retinal layer discontinuity was observed in four eyes, all of them involving the inner segment/outer segment (IS/OS) layer,interdigitation zone and retinal pigment epithelium. Involvement of the outer plexiform and outer nuclear layers and the external limiting membrane was observed in three cases (Table 1).

Postoperatively, OCT demonstrated complete resolution of fluid in two patients, with no recurrence during follow-up (follow-up duration was 26 weeks in 1 patient and 100 weeks in the other patient) (**Figures 1 and** **2**). Total reabsorption was documented after six and a half months of follow-up in one patient (patient number 6) and after 25 months in the other (patient number 4). No additional procedures were performed in either case.

Progressive fluid reabsorption occurred in the remaining 4 patients (numbers 1, 2, 3 and 5), which, however, was still incomplete at the time of preparation of the present paper. Patient number 5 underwent 25-gauge pars plana vitrectomy, peeling of the inner limiting membrane under visualization with brilliant blue dye, inversion of the pedicled flap at the temporal margin of the optic disc and 15% C3F8 injection, 5 months after the initial procedure (gas injection followed by photocoagulation).

Four patients received carbonic anhydrase inhibitors during the postoperative period, by the oral route (250 mg to 1 g per day) in three cases and by topical application (every 8 hours) in the fourth case. The duration of use of the medication ranged from 30 days to 30 months.

BCVA improved, at least one line, in all patients. Median BCVA was 20/80 before surgery and improved significantly to 20/32 at last follow-up after intravitreal gas plus laser. Four patients had BCVA of 20/40 or better. Median follow-up duration was 15.34 months (range: 4 to 52 months).

**DISCUSSION**

The use of laser alone for the treatment of OPD-associated macular detachment was first reported in 1969 by Gass (18), who used xenon laser in order to create chorioretinal adhesion at the temporal margin of the disc in order to minimize the movement of fluid from the pit to the subretinal space in two patients. In 1972, Mustonen used argon laser in three patients with the same objective and observed slow reabsorption of subretinal fluid (19). In our patients, we used intravitreal C3F8 in addition to laser. With proper positioning, the gas bubble exerts pressure on the inner retinal surface and induces passive subretinal fluid migration through the retinal pigment epithelium and choroid. Consequently, it reduces the distance between the retinal layers, thus facilitating photocoagulation and subsequent adhesion between the outer layers of the retina and the retinal pigment epithelium (2, 20).

The duration between C3F8 injection and retinal photocoagulation along the temporal margin of the optic disc in our patients was three days, in contrast to the study by Lei (20), who applied laser one or two weeks after gas injection. We prefer a briefer period of face down positioning, which is more convenient for the patient. Another difference in our technique compared to that of Lei et al. was the C3F8 concentration, which was 100% in the present study and 66% in the former. We prefer a higher concentration of C3F8 since that usually generates a larger bubble which exerts a higher pressure over a greater retinal area; this, in turn, may be associated with more efficient intraretinal and subretinal fluid drainage.

All patients were treated with 360-degree peripheral retinal photocoagulation prior to intravitreal C3F8 injection for prophylaxis against rhegmatogenous retinal detachment. We believe that posterior hyaloid detachment, expansion, movements and the mechanical forces triggered by the intraocular gas may generate traction on the peripheral retina, with the risk of retinal tear and detachment. None of these complications were observed during patient follow-up.

An important characteristic of the treatment strategy reported herein is the slow resolution of intra- and subretinal fluid. The fastest total reabsorption was observed six and a half months after treatment. Visual acuity started to improve concomitantly with the beginning of fluid reabsorption identified on OCT. We believe that careful follow-up of patients who are improving is preferable to administering multiple treatments. In contrast, worsening of visual acuity associated with increased intraretinal or subretinal fluid OCT is an indication for additional therapeutic approaches, as was the case for patient number 3 (additonal laser treatment was applied 70 days after the initial procedure) and patient number 5 (who was treated with pars plana vitrectomy).

Visual acuity improved in all patients reported herein. Even the four patients with partial fluid reabsorption had improvement in visual acuity. There was no significant association between discontinuity of the retinal layers on OCT or duration of symptoms and visual prognosis.

Progressive fluid reabsorption and the closure of communication between the subretinal and intraretinal spaces with the optic pit occurred in 5 of the 6 cases reported after intravitreal gas, face down and laser. This technique failed in the oldest patient studied (a 52-year-old woman), who probably had greater liquefaction of the vitreous gel with a consequent greater potential of dissection of the latter. We propose two potential explanations for the one failed case: 1) even with face-down positioning, there is not enough time for retinal compaction so that the laser will have a healing effect on all retinal layers. The liquefied vitreous gel may infiltrate the intra- and subretinal space more easily as soon as the patient abandons face-down positioning even for short time intervals; 2) a lower healing capacity of older patients. For this reason, pars plana vitrectomy may be necessary in older patients. During vitrectomy, peeling of the inner limiting membrane is performed and an internal limiting membrane flap is prepared and positioned over the pit in an attempt to prevent the entry of fluid from the vitreous into the sub- or intraretinal space. Further, vitrectomy permits placement of a more voluminous C3F8 bubble, which probably leads to more effective and longer lasting tamponade of the temporal margin of the optic disc. This provides a longer healing time after retinal photocoagulation, which may be performed intra- or postoperatively. Some patients with ODP-associated macular detachment are treated only by vitrectomy, without using flaps or endolaser*.* Those who recommend this technique believe that removal of the hyaloid and prediscal membranes may create a communication between the subarachnoid space and the vitreous cavity, preventing the fluid from that space from migrating towards the retinal tissue.

The use of a carbonic anhydrase inhibitor varied among patients according to an individualized approach respecting the tolerance and contraindications for each case. The rationale for this prescription is the stimulation of the mechanism of fluid pumping outside the subretinal space by the cells of the retinal pigment epithelium. However, the current small case series does not permit an assessment of the potential impact of carbonic anhydrase inhibitors on OPD-associated macular detachment.

Clinical examination of patient number 4 showed a possible optic disc pit in the right eye, which was confirmed on OCT (**Figure 2**). Cases of optic disc pit not associated with maculopathy should not be treated prophylactically with laser along the temporal margin of the disc. The natural history of this disease may not involve the development of maculopathy and the risk of injury to the papillomacular bundle does not justify this approach (2).

The present study is limited by a small sample size, its retrospective nature, and lack of control group. The low incidence of ODP-associated maculopathy and the existence of multiple therapeutic options represent challenges in conducting comparative studies.

The procedure described herein represents a low cost alternative therapeutic approach for the management of ODP-associated macular detachment, and is associated with outcomes similar to those obtained with the surgical procedures mentioned earlier (20). It may be of particular interest in countries with limited public health resources and lack of universal access to vitreoretinal surgeries.

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**Table 1: Clinical characteristics of 6 patients with optic disc pit-associated macular detachment, OCT findings and outcomes.**



\*Patient with optic pit in both eyes.

Abbreviation: M male, F female, RE Right eye, LE left eye, SRF subretinal fluid, ONL outer nuclear layer, GCL ganglion cell layer, INL inner nuclear layer, NFL nerve fiber layer, PPV *pars plana* vitrectomy, ILM internal limiting membrane, OPL outer plexiform layer, ELM external limiting membrane, IS/OS inner segment/outer segment junction layer, IZ interdigitation zone.

**Fig 1: Patient number 6: OCT at baseline and follow-up visits**

**Uma imagem contendo interior, olhando, gato, foto

Descrição gerada automaticamente**

A. Macular infrared hyporreflectivity due to serous retinal detachment and a defect at the temporal margin of the optic disc. OCT image confirms serous macular detachment.

B and C. OCT image with improvement of subretinal fluid one month and two months after gas tamponade and retinal photocoagulation along the temporal margin of the optic disc, respectively.

D. OCT image with complete resolution of the subretinal fluid after six months

**Fig 2: Patient number 4: OCT at baseline and follow-up visits**

**Uma imagem contendo verde

Descrição gerada automaticamente**

A. Infrared image showing a discrete optic disc pit in the right eye and macular circular infrared hyporreflectivity due to serous retinal detachment in the left eye. OCT image showing a steep temporal optic disc margin with normal retinal layers in right eye and serous macular detachment in the left eye at baseline

B. OCT image with improvement of subretinal fluid one month after gas tamponade and retinal photocoagulation along the temporal margin of the optic disc in the left eye.

C. OCT image after one year of follow-up with residual intraretinal and subretinal fluid in the left eye.

D and E. OCT image with complete resolution of the subretinal fluid after two and four years of follow up, respectively. Right eye with no change during six years of follow-up.