

Primary vitrectomy with Densiron-68 for rhegmatogenous retinal detachment

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Abstract

Background To report a retrospective non-comparative interventional study on the effectiveness and ocular tolerance of a heavy silicone oil tamponade (HSO, Densiron-68) for primary inferior rhegmatogenous retinal detachment (RRD).

Methods Forty-one eyes of 41 consecutive patients were recruited between January 2004 and August 2006. Primary vitrectomy with Densiron-68, a heavy silicone oil, was used in all cases. Inclusion criteria were primary RRD with at least one retinal break between 4 and 8 clock hours. The study protocol consisted of a minimum of eight clinic visits: baseline, surgery, 1 week, 1 month and 3 months after the initial surgery; removal of oil and 1 week, 1 month and 3 months postoperatively. The primary endpoint was anatomical re-attachment of the retina. Cases were judged successful when there was reattachment of the retina in the absence of any tamponade agent. The secondary endpoint was to record the visual function and any complications arising from the surgery. Out of 41 patients initially included in the study, 33 completed all follow-up visits.

Results Anatomical success was achieved in 91% of cases (30 out of 33) with one retinal operation, and rose to 94% (31 out of 33) with additional surgery. Mean visual acuity improved from logMAR 1.19 (SD 0.9) to 0.5 (SD 0.51, $p=0.001$). No significant ocular hypertension, clinically significant emulsification of the tamponade or inflammation developed during follow-up.

Conclusion With Densiron-68, high anatomical and functional success rates can be achieved with primary vitrectomy for RRD and predominantly inferior pathology.

Keywords Semifluorinated alkanes · Perfluorohexyloctane · Primary inferior · Rhegmatogenous retinal detachment · Heavy silicon oil

Introduction

The use of pars plana vitrectomy (PPV) for the treatment of rhegmatogenous retinal detachment (RRD) has gained increasing popularity over the past 20 years. The majority of RRD is associated with breaks above 10 to 2 clock hours, where the use of gas or silicone oil is well-tolerated and well-accepted in the clinical management [3, 4, 10, 13, 14]. RRDs with retinal breaks between 4 to 8 clock hours are generally more difficult to treat, due to limited tamponade effects of conventional gas or silicone oil tamponade agents in the usual supine or upright postoperative positioning of the patient. Moreover, a mixture of aqueous humour and growth factors (“PVR soup”) is concentrated in the inferior retina and at the posterior pole [9]. These types of RRD with isolated inferior retinal breaks can be treated successfully with a conventional segmental scleral buckling (SB) procedure [18, 27]. However, when there is a complex RD or when retinal breaks are in an inconvenient position to buckle, PPV is required [15, 24, 25].

The theoretical advantages of heavy tamponades in these situations are: 1) the immediate interruption of an open communication between the preretinal and the subretinal space, 2) support of the lower fundus periphery in the upright and supine positions, and 3) the displacement of the proliferative mixture away from the posterior pole in the upright and supine positions.

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Early heavier than water tamponades were associated with relatively high complication rates, for example increased emulsification, intraocular inflammation and rise in intraocular pressure; however, with the newer generation of heavy tamponades (mixtures of conventional silicone oils with partially fluorinated alkanes), the complication rate could be greatly reduced [6]. The aim of our study was to evaluate Densiron® 68, one of the newly developed heavy silicone oils, as an internal tamponade in the treatment of primary inferior RD.

Material and methods

Study design

We performed a retrospective non-comparative interventional study of consecutive eyes undergoing pars plana vitrectomy with Densiron 68 tamponade during the first surgical intervention in patients with RRD with or without proliferative vitreoretinopathy (PVR) at St Paul's Eye Unit, Royal Liverpool University Hospital between January 2004 and August 2006.

All patients presented with a primary RRD with at least one retinal break between 4 and 8 clock hours. Patient with breaks above 10 to 2 clock hours were not treated with a heavy silicone oil tamponade (HSO) during the initial surgery. The choice of tamponade was made at the surgeon's discretion. We excluded patients younger than 18 years, with severe systemic disease, or who were pregnant, as well as any with uncontrolled ocular disease or previously failed retinal detachment surgery (Table 1).

Examinations

Pre- and postoperative examinations included a detailed history of ophthalmic surgery and of the retinal detachment, refracted best-corrected visual acuity using ETDRS charts,

slit-lamp biomicroscopy with particular attention to depth and inflammation of the anterior chamber, Tonopen tonometry for intraocular pressure (IOP), and indirect ophthalmoscopy with particular attention to quadrants involved in retinal detachment and PVR. The presence and grade of PVR grade was defined according to the updated classification of Machemer et al. [11]. Anterior chamber flare was measured utilizing a 1 mm spot beam, and was defined in the following manner: (a) Tyndall effect barely discernible = 1+, (b) Tyndall beam in the anterior chamber of mild intensity = 2+, (c) Tyndall beam in the anterior chamber of strong intensity = 3+, and (d) Tyndall beam in the anterior chamber very intense with milky aqueous = 4+. The presence of silicone oil emulsification was carefully noted.

The follow-up examinations were scheduled at 1 day, 1 week, 1 month with HSO in, and 1 week, 1 month and 3 months after HSO removal.

Surgical technique

Surgery was performed with monitored general anesthesia or a retrobulbar block. The surgical procedure included a standard three-port pars plana vitrectomy using the ACCURUS® vitrectomy machine (Alcon Laboratories, Inc.). During vitrectomy, the vitreous base was thoroughly trimmed and drainage retinotomies were performed in nine eyes. In 27 cases, perfluorocarbon liquid were used to assist surgical procedures. In seven patients, a 180° peripheral inferior retinectomy was needed in order to mobilise the inferior retina and relieve traction. The retinal periphery was inspected for retinal breaks, and any breaks found were treated in one case with cryocoagulation alone, in 33 cases with endolaser photocoagulation, and in seven cases with a combination of both. Fluid–air exchange was then performed with humidified air. At the end of the surgical procedure, HSO was injected. The surgeons always aimed to achieve a complete fill. All patients were postured on their backs for 3 hours postoperatively; thereafter, the patients were postured on the side of the breaks. All postures were adopted for 10–14 days.

HSO removal was planned within 3 months of the initial surgery (142±81 days). The HSO was aspirated using the active aspiration of the vitrectomy system ACCURUS® (Alcon) with an aspiration rate of 600 mmHg. No complications were noticed during the removal. Patients for whom HSO endotamponade failed were treated with further surgeries using standard silicone oil.

Outcome measures

Our main study endpoint was retinal reattachment after the removal of HSO. The anatomical reattachment of the retina

Table 1 Demographic characteristics of study patients

No. of patients	41
Age	59±16
Sex (male/female)	19/22
Phakic/pseudophakic	28/13
No. of breaks	1.8±1.4
Location of breaks (clock hours)	4–8
Macula status on/off	22/19
PVR	
A	11
B	6
C (1–4)	6

was judged successful when there was reattachment of the retina in the absence of any tamponade agent.

We also analysed the functional outcome and complications with particular attention to the visual acuity, to the behaviour of intraocular pressure (IOP) and to depth and inflammation of the anterior chamber.

Results

Patients and preoperative findings

Out of 41 patients initially included in the study, 33 completed all follow-up visits. Forty-one eyes (28 phakic, 13 pseudophakic) of 41 patients (19 male, 22 female) with a median age of 59 years (range 18–91 years), were treated with primary vitrectomy and HSO tamponade (Densiron® 68, Fluoron GmbH, Neu-Ulm, Germany). At the time of the preoperative examination the macula was attached in 22 eyes and detached in 19, with a mean extension of 2.4 (SD 0.8) quadrants of detached retina. The mean number of breaks was 1.8 ± 1.4 , range 1 to 5. One patient presented with a break at the posterior pole. Twenty-three RRDs were complicated by 11 eyes PVR A, six eyes PVR B, six eyes PVR CP (1–4).

Anatomical results

Retinal reattachment was achieved in 91% of cases (30/33 cases) after the first surgical approach. Persistent sub-retinal fluid (SRF) could be seen in one patient (1/33 cases, 3%) at 1 month after the initial surgery. HSO was removed within 3 months of the initial surgery (142 days, SD 81). Before oil removal, all retinas appeared attached; the laser scars were pigmented and retinotomies were scarred. Following tamponade removal, 31 out of 33 eyes (94%) had retinal reattachment, whereas two eyes had recurrent retinal detachment. These two developed a superior

retinal detachment that needed a retinectomy. In all re-detachments, standard silicone oil was used as endotamponade.

At 1 month after tamponade removal, 31 eyes out of 33 (94%) had retinal reattachment and at 3 months follow-up after tamponade removal, the retina was still attached in 30 eyes out of 33 (91%).

Functional results

At baseline examination, mean best-corrected visual acuity was 1.19 ± 0.9 logMAR, and at the 3-month follow-up, mean best-corrected visual acuity was 0.56 ± 0.51 logMAR. Preoperative and postoperative values were significantly different (two-tailed Student's *t*-test, $p = 0.001$).

Best-corrected visual acuity improved in 29 out of 33 cases (87.8%), and decreased in four out of 33 (12.1%), all of which presented with an attached macula at the time of surgery. Table 2 summarizes all data on our study.

The IOP was 15.7 (SD 3.8) mmHg at baseline, 21.3 (SD 9.7) mmHg at 1 week and 21.3 (SD 10) mmHg at 1 month with HSO in situ. Following Densiron-68 removal, IOP levels were 17 (SD 5.6) mmHg at one week, 16.4 (SD 7) mmHg at 1 month and 16 (SD 5.1) at 3 months after removal of HSO. In five cases at 1 week and in eight cases at 1 month an elevated IOP had been measured. In one case, elevated IOP persisted through to the 3-month follow-up after HSO removal in one case. In all cases, increased IOP could be controlled with topical and/or temporary oral administration of anti-glaucomatous medication. The difference in IOP was not significantly different between baseline and the last follow-up at 3 months after HSO removal ($p = 0.26$, *t*-test paired).

Complications

Anterior chamber shallowing occurred in two out of 41 eyes (4.8%), one of which was phakic. Emulsification

Table 2 Anatomical and functional outcomes at different follow-up intervals

Variable	Baseline: <i>n</i> =41 (%)	1 wk HSO in: <i>n</i> =33 (%)	1 mth HSO in: <i>n</i> =33 (%)	1 wk HSO out: <i>n</i> =33 (%)	1 mth HSO out: <i>n</i> =33 (%)	3 mths HSO out: <i>n</i> =33(%)
Anatomical outcomes						
Success rate		31 (94)	32 (97)	31 (94)	31 (94)	30 (91)
Functional outcomes						
Best VA logMar	1.19 ± 0.94	1.1 ± 0.46	0.96 ± 0.50	0.78 ± 0.54	0.7 ± 0.63	0.56 ± 0.51
Best VA ≤ 0.4 logMar	10 (24.3)	1 (3)	1 (3)	5 (15.15)	13 (39.3)	15 (45.5)
IOP	15.7 ± 3.87	21.3 ± 10.1	20.8 ± 9.6	17 ± 5.6	16.4 ± 7	16 ± 5.1
AC cell	0	0.32 ± 0.5	0.3 ± 0.5	0.34 ± 0.59	0.20 ± 0.48	0.13 ± 0.34
AC flare	0	0.10 ± 0.31	0.08 ± 0.27	0.05 ± 0.23	0.03 ± 0.17	0

could be observed in two cases out of the 41 (4.8%), but was not clinically significant. None of the patients had clinical significant intraocular inflammation with HSO in situ or after the removal. Posterior synechiae were detected in two patients (4.8%) at 1-month follow-up. Fifteen phakic patients (53.5%) developed cataract during the follow-up, and 13 of them (46.4%) underwent cataract surgery (Table 3).

Discussion

One of the inherent problems in the use of PPV with the conventional intraocular tamponade agents is the difficulty of producing a direct tamponade effect on inferior retinal breaks [5, 22]. Different surgical techniques have been advocated for this complicated subset of patients, ranging from vitrectomy without internal tamponade [13], vitrectomy with gas tamponade but without scleral buckling [19, 22], and combined scleral buckling for primary cases [1]. A novel approach is the use of heavy silicone oil tamponades in such cases [15].

There are several arguments that support the use of a heavier than water tamponade for the treatment of RRD with inferior breaks. One of these is the ability to displace pre-retinal and sub-retinal fluid from the lower part of the fundus, thereby creating an instant adhesion of the retinal breaks and the underlying retinal pigment epithelium. In the case of residual traction around the break, the interfacial tension would prevent the tamponade going through the break, and at the same time aqueous could not gain access to the subretinal space. In addition, a faster and enduring reattachment of the posterior pole should be achieved in the usual supine and upright positions. Finally, the mixture of residual aqueous and growth factors that stimulate PVR development is shifted to the superior periphery (where redetachments are easier to treat) and away from the posterior pole. In this series, the use of Densiron-68 in primary RRD with inferior pathology was associated with a

comparably high anatomical and functional success rate. Moreover, no major complications could be seen in terms of corneal damage, cataract development, clinical significant emulsification, elevation of intraocular pressure, ocular hypotension and intraocular inflammation.

Sharma et al. reported a primary success rate of 81% in patients with RRD for inferior breaks treated by pars plana vitrectomy and gas. The author concluded that face up, or right or left side down positioning will tamponade breaks satisfactorily, avoiding the complication of combined surgery involving a supplementary SB [18].

It has been also proved that the combination of scleral buckle surgery with PPV leads to an adequate support to inferior retinal breaks, with a success rate after one procedure in about 89% of the cases [2]. However, combining scleral buckle surgery with PPV may increase the risk of intraoperative and postoperative complications (especially choroidal haemorrhage) which occur more frequently in combined surgery [20, 23].

Rizzo et al. report the use of a new agent, HWS 46–3000, as a long-term endotamponade in RD arising from inferior or posterior tears. HWS 46–3000 was associated with a success rate of 84.6% with a single surgery, and an overall success rate of 100% at 6 months with a second operation and conventional silicone oil endotamponade [15].

Using Densiron-68, Sandner et al. noted a low anatomical success rate (33.3%) in a small case series of 12 patients with inferior complex rhegmatogenous retinal detachment with secondary PVR [17]. Re-detachment seems to be more frequent within the posterior staphyloma in highly myopic patients, suggesting that there was not enough pressure effect within the staphyloma [16].

In a wider study reported by Herbrig et al., the anatomical success rate achieved with Densiron-68 in complicated retinal detachment was 87.6% (78 out of 89 eyes) at 9-month follow-up. These findings supported the hypothesis that Densiron-68 can be a effective tamponade agent also in inferior complicated retinal detachment when a previous operation has failed [8].

In our series, primary retinal reattachment was achieved in 91% of cases (30 out of 33 eyes) with one retinal operation at the 3-month follow-up. This was achieved without supplementary SB; therefore, our results may indicate the effectiveness of the heavy oil in treating inferior retinal pathology. Final anatomical success at the last follow-up was achieved in 94% of cases (31 out of 33 eyes). Two highly myopic patients developed a superior recurrence of RD within the area of the staphyloma after removal of HSO. In the presence of staphyloma, the HSO seems equally unable to fit into the “nooks and crannies”, as it behaves very much like conventional silicone oil, just “upside down”, as previously reported by Wetterquist et al.

Table 3 Cause of complication as judged by the surgeon during the follow-up period

Complication	Frequency	Percentage
Newly diagnosed break	0	0
PVR	1	2.4
Old break reopened	2	4.8
Recurrent retinal detachment	4	9.7
Oil in AC	2	4.8
Raised intraocular pressure	1	2.4
Cataract	15	53.5
Posterior synechie	2	4.8
Elevated edge of retinectomy	1	14

in a model eye chamber [21]. A reoperation with 180° retinectomy with standard silicone oil tamponade was carried out in both eyes.

Cataract formation and the need for oil removal remain the main drawbacks of HSO surgery. Cataract formation is likely related to its contact to the lens. Out of 28 eyes that were phakic at baseline, 15 developed early cortical and subcapsular lens opacity during the follow-up, and therefore underwent a phacoemulsification with intraocular lens implant.

In our study, we report that 15 out of 28 patients (53.5%) developed cataract during the follow-up, and 13 out of 28 of them (46.4%) underwent cataract surgery.

Analyzing the subgroup of phakic patients in the SPR study, cataract progression was 77.3% (96/209) in the vitrectomy group, vs 45.9% (160/207) in the scleral buckle group [7]. Cataract complication in our series is comparable to that of conventional primary vitrectomy, whereas the scleral buckle carries a lower cataract progression rate, but also a higher re-detachment rate at 26.3% (55/209) [7].

Further complications were relatively mild, with transient elevated IOP higher than 30 mmHg in five cases (12%) at 1 week and in eight cases (23.5%) at 1 month following Densiron-68. In one case only (2.4%), the elevated IOP persisted up to 3 months after HSO removal, but could be controlled with topical anti-glaucoma medication. We did not observe a pupil-block mechanism in this series of patients.

In a recent case-control study conducted on 128 eyes to compare the postoperative IOP in patients treated with Densiron-68 with those treated with conventional silicon oil, we found a higher IOP in the early postoperative period in the Densiron-68 group. By the 4th week from the surgery, the IOP difference between the two groups was insignificant ($p=0.17$), although the raised IOP in Densiron-68 group was more difficult to treat in some cases [26].

In a retrospective study of 40 patients receiving Densiron-68, Majid et al. described in 8 patients a significant emulsification that necessitated its removal. Analysing the observed side effects in our series, we found no presence of clinically significant emulsified Densiron-68 or intraocular inflammation [12].

There are anecdotal reports of sticky silicon oil in association with heavy tamponade, but no evidence can be found in the literature. We have not encountered such a complication in any case removing Densiron-68 [6].

In summary, this retrospective study shows that Densiron-68 provides retinal support in the inferior quadrants, and endotamponade effect in uncomplicated rhegmatogenous retinal detachment, with high primary success rate and without the need for supplementary SB combined surgery. Our study suggests that these objectives can be achieved with HSO.

Further prospective randomized trials are warranted to determine whether HSO may be superior to conventional treatments in this form of RRDs.

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