

Can the Sequential Use of Conventional Silicone Oil and Heavy Oil be a Strategy for the Management of Proliferative Vitreoretinopathy?

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Abstract

Introduction: Densiron is a novel long-term tamponade. Its specific gravity is 1.06 g/mL and as such it is heavier than water and provides support for the inferior retina. As proliferative vitreoretinopathy (PVR) has a propensity for the inferior retina, we used Densiron on a consecutive series of 97 cases with inferior pathology. We hypothesised that the sequential use of conventional and heavy silicone oil is a strategy for the management of PVR. **Materials and Methods:** A consecutive interventional case series involving the use of Densiron for PVR cases was studied. Patients were selected if conventional silicone oil and Densiron were used sequentially. Anatomical success was defined as total re-attachment in the absence of any tamponade agent for at least 3 months post oil removal. **Results:** Of the 97 patients, 10 patients fulfilled the criteria. Surgery involving Densiron was successful in re-attaching the retina in 7 of 10 cases, with one sequence of alternating light then heavy oil operation, and with one further surgery using silicone oil in the remaining 3 cases. The mean LogMAR preoperative vision was 1.57 and the postoperative vision was 0.82. In 8 of 10 patients, the final vision was 20/200 or better; in 5 of 10 patients, 20/80 or better. The mean follow-up was 19.5 months (range, 9 to 45). **Conclusions:** The sequential use of conventional silicone oil and Densiron may be a strategy in reducing the number of re-operations. Our case series shows that despite multiple surgical procedures, favourable visual outcome can be achieved.

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Introduction

Advances in vitreoretinal surgery have greatly increased the anatomical re-attachment rate in cases with proliferative vitreoretinopathy (PVR).¹ The availability of perfluorocarbon liquids,^{2,3} indirect viewing systems for surgery,^{4,5} illumination systems allowing bimanual dissection, the use of dyes^{6,7} and the use of retinotomies have all contributed to achieving a complete re-attachment of the retina in up to 90% of cases or even higher.⁸ Yet, despite these advances, re-operation is a feature of the treatment of PVR and final visual acuity is often poor.^{9,10}

Densiron is a novel heavier-than-water tamponade with a specific gravity of 1.06 g/mL. It is sometimes referred to as “heavy silicone oil”. Densiron is a homogenous mixture of perfluorohexyloctane (specific gravity 1.35 g/mL) and conventional silicone oil (0.97 g/mL). By varying the

proportion of the 2 liquids, it is possible to achieve solutions of different specific gravities. In the past, we have justified the choice of a specific gravity of 1.06 g/mL, based on measurements using a model eye chamber.¹¹ We have also considered the possible trophic effect of having agents that are too “heavy” or too “light”.¹²

In a pilot study of our first 42 cases in Rotterdam and Liverpool, we used Densiron for the treatment of retinal detachment arising from inferior retinal breaks for patients incapable of sustaining a head-down posture and in cases complicated by PVR.¹³ The success rate with one operation using Densiron was 81% and with further surgery, 93%. At the end of the study, all tamponade agents were removed in 90% of patients. Visual acuity improved from a mean LogMAR of 1.41 (SD, 0.64) to 0.94 (SD, 0.57), $P = 0.001$.

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In the past, we have argued that no single tamponade agent can achieve a “total tamponade effect”.¹⁴ Filling the vitreous cavity completely is not feasible because the shape of the globe approximates a sphere, such that a slight under-fill (with a tamponade agent) would leave a large area of the retina unsupported.¹⁵ It is also impossible to totally extirpate the vitreous body; any residual gel would be “compressed”, causing a relative under-fill postoperatively. It is logical to conclude that a tamponade agent that floats like silicone oil would be more effective at supporting the superior retina and an agent that sinks like Densiron would conversely be more efficient at tamponading the inferior retina.

When a retinal detachment recurs in the presence of silicone oil, the inferior fundus is affected, the subretinal fluid is shallow, the epiretinal membrane is usually diffuse and subretinal fibrosis is often present. Crucially, the upper fundus often looks securely attached, especially if 360-degree retinopexy had been applied. Whilst it is possible to perform further surgery involving removal of silicone oil, membrane peel and relieving retinotomy for the inferior pathology, the re-introduction of silicone oil means that the patients would need to be in a face-down position. Even in this position, silicone oil is not the most efficient tamponade agent as it provides the best support for the posterior pole rather than the inferior retina, where the retinal break or retinotomy edge is situated.

Our hypothesis is that the sequential use of light and heavy oils (conventional and Densiron) is more efficient at dealing with recurrent retinal detachment. It might reduce the number of re-operations and result in better visual acuity.

Materials and Methods

Densiron-68 (Fluoron company, Neu-Ulm, Germany) with an interfacial tension against water at 25°C of this solution of 40.82 mN/m; a specific gravity of 1.06 g/mL and a viscosity of 1400 mPas.

This is a prospective audit of a consecutive cohort from an interventional study. The initial pilot study to evaluate the safety and efficacy of Densiron received the approval of our hospital ethics committee. A pro forma was used to record the features of the preoperative clinical features and postoperative findings at every visit.¹³ The forms were designed to capture specific complications which we found from a previous multi-centred clinical trial of perfluorohexyloctane; we paid particular attention to dispersion, inflammation and epiretinal membrane formation.¹⁶

The first 97 patients from the cohort were reviewed at this audit. Cases treated with sequential light and heavy oils were identified using the following criteria:-

Inclusions: patients were selected if they had retinal

detachment complicated by PVR, for which conventional silicone oil and Densiron were used sequentially.

Exclusions: patients with retinal detachments as a result of posterior perforating injuries; proliferative diabetic retinopathy; patients with any tamponade agents still in situ.

Simple descriptive statistics were used to describe this non-comparative study.

Results

Of the 97 patients, 10 fulfilled the inclusion criteria. In 9 of 10 patients, retinal detachment recurred with silicone oil in situ and Densiron was used subsequently. In the remaining 1 patient, Densiron was used as the initial long-term tamponade and conventional oil was then used when retinal detachment recurred.

Another 4 patients had sequential light and heavy oils; 2 of whom were excluded because they had oil in situ at the time of writing this report and the other 2 patients were excluded because their retinal detachments arose from severe posterior perforating injuries.

Therefore, there were 10 eyes in the 10 selected patients; 5 were right eyes. The mean age of the 10 patients was 61.5 years (range, 44 to 77); there were 5 males.

Initial presentation: Uveitis was a feature in 1 of the 10 patients (++ to +++). In 2 of the 10 patients, the first presentation of the retinal detachments was associated with vitreous haemorrhages.

Pre-existing ophthalmic conditions: Two patients developed the initial retinal detachments following surgery for full thickness macular holes. In 1 of the 10 patients, the affected eye was known to be profoundly amblyopic.

Previous surgeries: In the 10 patients, there was a mean of 2.1 previous vitreoretinal operations (median, 2.0), ranging from 0 to 5 surgeries before Densiron was employed. In 1 patient, the previous operation involved a 180-degree relieving retinotomy. At some stage, all eyes had retinal detachments involving the macula.

Lens status: All patients were pseudophakic; 7 of 10 had intact posterior capsule and 3 had breached capsules.

Visual acuity: The mean preoperative LogMAR visual acuity was 1.57 (median, 1.48). The mean final LogMAR vision at the last follow-up was 0.82 (median, 0.8).

Surgeries involving Densiron: In all patients with silicone oil in situ, this was removed via a 16-gauge needle. Epiretinal membranes were peeled. In 8 of 10 patients, an inferior retinotomy was performed.

Removal of Densiron: The heavy oil was left in situ between 3 and 6 months. Removal involved a 3-port pars plana approach; an 18-gauge aspiration needle was used in

conjunction with a viscous fluid injection syringe in aspiration mode (maximum suction with full treadle was 600 mm Hg).

Complications: Four of 10 patients had raised intraocular pressures above 30 mm Hg postoperatively; 1 patient had a small Densiron bubble in the anterior chamber and 1 patient had visible emulsification of silicone oil.

Anatomical outcome: In 7 of 10 patients, Densiron was removed and the retina remained attached. In 3 of 10 patients, a superior retinal detachment occurred in the presence of the Densiron. In those 3 patients, the Densiron was removed, further dissection of epiretinal membrane was carried out and conventional silicone oil was injected after supplementary endolaser retinopexy. In none of the 3 cases was retinotomy necessary. All 3 cases subsequently underwent silicone oil removal without further recurrent retinal detachment. For the 10 patients, 7 had a sequence of alternating light and heavy oil, 3 patients had an extra sequence of light, heavy then light oil.

Further operations after Densiron: All patients had at least one further surgery to remove the Densiron, 3 had one more operation involving silicone oil as described above. The mean number of operation after Densiron was used was 1.4 surgeries.

Follow-up: The mean follow-up was 19.5 months (range, 9 to 45).

Visual outcome: Mean LogMAR preoperative vision was 1.57 (Snellen 20/740) and the mean final postoperative LogMAR vision was 0.82 (Snellen 20/132). [The median preoperative vision was 1.48 (Snellen 20/600) and median final vision was 0.8 (Snellen 20/126).] In 7 of 10 patients, the vision improved, remained unchanged in 1 and deteriorated in 2. The best final LogMAR visual acuity ranged from 0.18 to 1.78. In 8 of 10 patients, the final vision was 20/200 or better; in 5 of 10 patients, 20/80 or better.

Discussions

In the past, we have published the results of a multi-centred prospective randomised controlled trial¹⁷ (PRCT) on the use of 5-fluorouracil and low molecular weight heparin as adjuvant to surgery in cases of retinal detachment with high-risk characteristics.¹⁸ This trial showed that the adjuvant can reduce the incidence of postoperative PVR, but a subsequent PRCT from the 2 original centres showed that 5-fluorouracil and low molecular weight heparin were not effective in lowering the re-detachment rate in cases with established PVR.¹⁹ Although the German group found a benefit with the use of daunomycin^{20,21} in reducing the number of surgeries, the effect is marginal and the drug is not widely used.

Re-operation with repeated vitrectomies is therefore a feature in the management of retinal detachments

complicated with proliferative vitreoretinopathy. Although the final anatomical success rate may be high, the numerous operations involved are often exhausting for the patient and the poor final visual outcomes are disappointing to the surgeon.

The sequential use of conventional oil and Densiron seemed to be a logical approach to re-operations. When recurrence of retinal detachment occurs with silicone oil in situ, the detachment affects the lower retina, where the PVR are preponderant. Densiron combined with a peripheral retinotomy maximises the relief of static traction and at the same time provides the most efficient tamponade to the side of the retinal incision.

Tamponade agent has another important function, which is the displacement of the aqueous from the surface of the retina.¹⁶ This aqueous contains cytokines and growth factors²² which promote re-proliferation. With conventional silicone oil, the upper retina can appear to be relatively free of PVR even when the inferior retina is elevated by epiretinal membrane. When Densiron is used subsequently, the heavy oil will displace the proliferative aqueous to the upper retina, which seems to be most secure. In this fashion, we were able to totally re-attach the retina in 7 of 10 cases. In the remaining 3 cases, another sequence of heavy to light oil secured total re-attachment. In all 10 patients, all oils were removed without further re-detachment.

The most significant finding in our small series of cases is the relative good final visual acuity. Three of the patients had pre-existing pathology; 2 with previous macula hole and 1 eye was amblyopic. Despite this and considering the number of re-operations including retinotomies in 8 of the 10 patients, the visual outcome was very encouraging. Five of the 10 patients had a final vision of 20/80 or better. The relative good visual acuity might be due to the fact that all the patients had prolonged internal tamponade such that even when retinal detachment recurred, the macula largely remained attached. The long-term use of tamponade would also have displaced the proliferative aqueous milieu away from the macula and perhaps thus reduced the chance of macular pucker, which is frequently associated with relieving retinotomies.¹⁹

We believe that the sequential use of light and heavy oils might be a promising strategy for the treatment of PVR. This needs to be verified with a greater clinical experience. If a sequential approach seems logical, we still do not know which sequence is best – that is, do we know which oil should be used initially, heavy or light? Fortunately, the answer to the last question may be addressed by the Heavy Silicone Study (HSO), an international PRCT led by Cologne, designed to find out if Desiron or conventional oil is more effective in treating PVR cases without retinal

breaks in the upper 4 clock hours of the retinal fundus. We await the results eagerly.

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