Int Ophthalmol (2016) 36:3–7
DOI 10.1007/s10792-015-0068-4

ORIGINAL PAPER

Long-term heavy silicone oil intraocular tamponade

Ian J. Dooley · Emma S. Duignan · Dara J. Kilmartin

Received: 19 January 2015 / Accepted: 23 March 2015 / Published online: 27 March 2015

Abstract Heavy silicone oil tamponade is intended to be temporary, but may occasionally be indefinite in patients who refuse, or are deemed unsuitable for, further surgery. The aim of this study is to compare the outcomes of patients with temporary versus indefinite heavy silicone oil intraocular tamponade. This retrospective, comparative case series identified 75 patients who underwent heavy silicone oil instillation (Oxane HD) over a 6 year period (2006–2012) in one institution. Thirty-nine patients had temporary heavy oil tamponade and 36 patients had indefinite tamponade. The majority (68 %) of patients had a history of previous vitreoretinal surgery prior to oil instillation and 66.7 % had pre-existing proliferative vitreoretinopathy (PVR). The mean final logMAR best corrected visual acuity (BCVA) was significantly better in the temporary tamponade group (1.34 ± 0.66) than the indefinite tamponade group 1.82 ± 0.64 ($p = 0.003$). Ambulatory BCVA (≥4/200) was retained in 76.3 % of temporary tamponade patients versus 54.3 % of indefinite tamponade patients ($p = 0.093$). Successful retinal reattachment was significantly more likely in temporary tamponade patients (92.3 %) than indefinite tamponade patients (75 %; $p = 0.04$). Complications in the patients with indefinite heavy silicone oil tamponade included redetachment (38.9 %), corneal pathology (13.8 %), secondary glaucoma (11.1 %) and anterior segment emulsification (8.3 %).While temporary tamponade patients had better outcomes than those with indefinite tamponade, the majority of indefinite tamponade patients still retained ambulatory vision in the affected eye. Indefinite heavy silicone oil tamponade remains a viable option for those who cannot undergo removal of oil surgery.

Keywords Heavy silicone oil · Proliferative vitreoretinopathy · Oxane · Retinal detachment · Tamponade

I. J. Dooley · E. S. Duignan (✉) · D. J. Kilmartin
The Royal Victoria Eye and Ear Hospital, Adelaide Road, Dublin 2, Ireland
e-mail: emmaduignan@rcsi.ie

Introduction

Heavier-than-water intraocular tamponades, also known as heavy silicone oils, have been available since the late 1980s to vitreoretinal surgeons. Earlier silicone oils with a lower specific gravity than intraocular fluid allowed fluid to accumulate under the oil, limiting the tamponage of inferior breaks and detachments [1]. After initial disappointing early results in both animal and human eyes [2–4], the most recent generation of liquids including Oxane HD, densiron and HWS 46-3000 have been better tolerated and are being used more widely [1, 5, 6].

Heimann et al. [7] reported several theoretical advantages of heavy oil in cases of complex inferior

retinal pathology. In addition to the fact that breaks and retinotomy edges in the lower periphery may be efficiently supported, while patients are in the upright position, a lower risk of proliferative retinopathy is theorised due to the removal of the "proliferative vitreoretinopathy (PVR) soup", pro-inflammatory proteins, aqueous and retinal pigment epithelial (RPE) cells, away from the area of inferior tamponade. This effect, along with the ability to tamponade the posterior pole, leads to a higher likelihood of superior future detachments rather than inferior, and of these detachments being of the 'macula on' type, which is preferable. Heavy oils have been associated with an extensive list of ocular complications, which include inflammation, re-proliferation, emulsification, increased IOP and potential retinal toxicity; for this reason, many earlier tamponade agents such as OL62HV and O62 were not recommended for further clinical use [7].

While the use of heavy oil tamponade is intended to be temporary, there exists a cohort of patients for whom removal is not possible or is not the preferred option [8]. The reasons for permanent heavy oil tamponade include patient preference, persistent hypotony, repeated retinal detachment (RD) following removal, recurrent vitreous haemorrhage in diabetic patients, patients with intellectual impairment and patients lost to follow-up. The purpose of this study was to compare the outcomes of both temporary and permanent heavy oil tamponade patients.

Materials and methods

We report a retrospective, comparative case series ($n = 75$), which compared the clinical outcomes of patients with temporary heavy silicone oil (Oxane HD, Bausch & Lomb, Toulouse, France) intraocular tamponade ($n = 39$, mean duration $\pm$ SD $= 9.6 \pm 10.4$ months) against patients with indefinite tamponade with the same agent ($n = 36$, mean duration to last follow-up $= 33.2 \pm 19.7$ months). All patients consecutively underwent 20-gauge pars plana vitrectomy with Oxane HD silicone oil tamponade for the treatment of rhegmatogenous RD by a single surgeon (DK) from October 2006 to May 2012 (44 months).

Oxane HD is a mixture of silicone oil (Oxane 5700; Bausch & Lomb, Toulouse, France) and a mixed fluorinated and hydrocarbonated olefin (RMN3). It has a specific gravity of 1.02 g/cm^3 at 25 °C and refractive index of 1.4 at 20 °C [7]. Visual acuity was measured using Snellen charts, and converted into logMAR units for statistical purposes. Ambulatory vision was defined as a visual acuity of 4/200 (logMAR 1.7) or better [9]. According to a modified scale of Avery et al. [10], non-numerical vision was arbitrarily assigned a logMAR value (counting fingers [CF] = logMAR 1.7, hand motion [HM] = logMAR 2.0, intact light perception = logMAR 2.3, defect light perception = logMAR 2.7, no light perception [NLP] = logMAR 3.0). All data were analysed using Aabel 3 (Gigawiz, USA) statistical analysis programme. A p value of <0.05 was taken to be statistically significant.

Results

The baseline characteristics and visual acuity outcomes of the two groups (temporary and indefinite tamponade) are shown in Table 1. Taking all 75 patients, the majority (51/75, 71.8 %) of patients had undergone previous vitreoretinal surgery. The indications for the patients' previous vitrectomy included rhegmatogenous retinal detachment (RRD; 36/75, 50.7 %), epiretinal membrane (ERM; 5/75, 7.0 %), full-thickness macular hole (FTMH; 3/75, 4.2 %), diagnostic vitrectomy (3/75, 4.2 %), intraocular foreign body (IOFB; 2/75, 2.8 %), complicated cataract surgery (1/75, 1.4 %) and excision of choroidal malignant melanoma (1/75, 1.4 %). The remaining 24 patients (28.2 %) had heavy silicone installation at the time of first vitrectomy. Anatomically successful retinal reattachment was achieved in 92.3 % of temporary tamponade patients and in 75.0 % of indefinite tamponade patients (X^2 test: $p = 0.04$). The mean logMAR BCVA (Table 1) was significantly worse postoperatively in the indefinite tamponade group (unpaired two-tailed Student's t test: $p = 0.003$). While ambulatory visual acuity was higher in the temporary group, this was not found to be statistically significant (X^2 test: $p = 0.093$).

All patients with PVR (temporary and indefinite tamponade) had significantly reduced mean logMAR BCVA (1.68 ± 0.66) compared to those without PVR (temporary and indefinite tamponade; 1.23 ± 0.77; unpaired student's t test: $p = 0.011$). However, when subdividing the groups by PVR status, in the temporary tamponade group, the mean BCVA of patients

Table 1 Summary of the baseline characteristics, visual outcomes and phakic status, of the temporary tamponade and indefinite tamponade patients

	Temporary $n = 39$	Indefinite $n = 36$	P value
Mean age at presentation (years)	53.6 ± 17.3	59.0 ± 18.3	0.158
Mean logMAR BCVA presentation.	1.15 ± 0.67	1.47 ± 0.82	0.069
Time to presentation (days)	46.7 ± 62.3	30.6 ± 65.6	0.029*
Previous Vitrectomy	64.1 %	72.2 %	0.546
PVR	64.1 %	69.4 %	0.708
Tamponade duration (months)	4.5 ± 1.5	33.2 ± 19.7	0.01*
Reattached at last visit	92.3 %	75.0 %	0.04*
Ambulatory VA > 4/200	76.3 %	54.3 %	0.093
Final logMAR BCVA	1.34 ± 0.66	1.82 ± 0.64	0.003*
Already Pseudophakic	25.6 %	27.8 %	0.98
(*n*)	10	10	
Combined phacoemulsification with Heavy oil insertion	17.9 %	8.3 %	0.285
(*n*)	7	3	
Subsequent phacoemulsification	15.4 %	11.1 %	0.80
(*n*)	6	4	
Phakic	41.0 %	52.8 %	0.32
(*n*)	16	17	
Significant lens opacity	12.8 %	27.8 %	0.265
(*n*)	5	10	

Means were compared with student's *t* test or Mann–Whitney *U* test with respect to parametric and non-parametric data, respectively

Percentages were compared with the Chi square test

Statistically significant results ($p < 0.05$) are denoted with an asterix

with PVR was not significantly less (1.46 ± 0.61) than that of patients without PVR (1.03 ± 0.61; unpaired student's *t* test: $p = 0.054$, Fig. 1). Similarly, in the indefinite tamponade group, the mean BCVA of patients with PVR (1.88 ± 0.61) was not quite significantly less than that of patients without PVR (1.49 ± 0.76; unpaired students *t* test: $p = 0.130$).

The mean IOP in the temporary tamponade group (14.1 ± 5.0 mmHg) was not significantly different to the mean IOP of the indefinite tamponade group (14.4 ± 5.3 mmHg; Mann–Whitney *U* test: $p = 0.57$). The temporary tamponade group had a 17.9 % secondary glaucoma rate. Of the four patients (10.3 %) who required transscleral cyclodiode laser therapy to control their IOP, one patient had pre-existing primary open-angle glaucoma, one had Marfan's syndrome and another had an intraocular foreign body. In the indefinite tamponade group, 11.1 % had secondary glaucoma; however, no patients in this group required an IOP lowering procedure.

In the temporary tamponade group, two patients (5.3 %) developed corneal pathology. One patient had a corneal ulcer, which resolved with topical treatment. The other developed band keratopathy and underwent phototherapeutic keratectomy in an attempt to remove it. Five patients from the indefinite tamponade group (13.9 %) had corneal pathology, three of whom had band keratopathy, but treatment was not considered to be potentially beneficial. The remaining two patients had bullous keratopathy. One declined further procedures and the other patient underwent evisceration for pain relief in the blind eye, following an unsuccessful penetrating keratoplasty. Anterior segment emulsification was noted in three of the indefinite tamponade group (8.3 %). All three patients elected not to have any further intervention.

A scleral buckle procedure was carried out in 10 patients in the temporary tamponade group (10/39, 26 %) and nine patients in the indefinite tamponade group (9/36, 25 %). Amongst those patients who

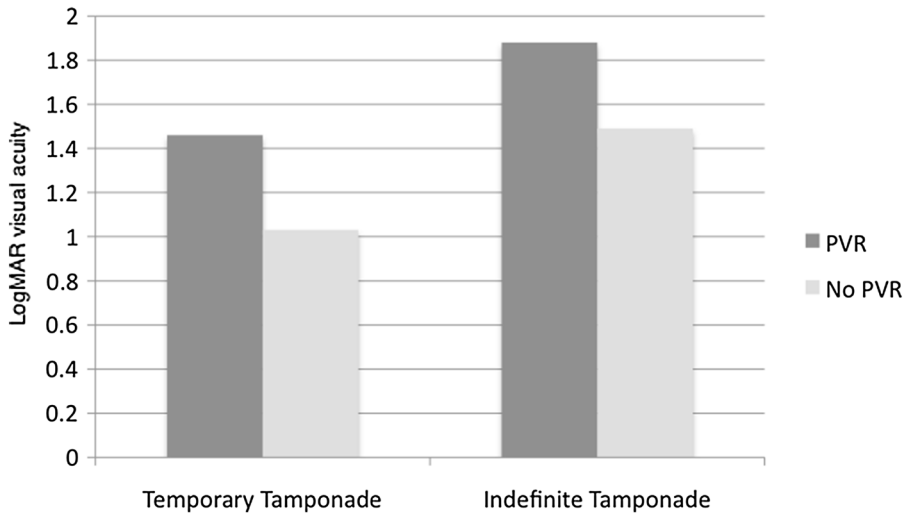

Fig. 1 Clustered Bar chart of the mean logMAR best corrected visual acuity (BCVA) with groups subdivided by tamponade and proliferative vitreoretinopathy (PVR) status. The mean logMAR BCVA of both the temporary tamponade group with PVR and the temporary tamponade group with no PVR were significantly less than that of the indefinite tamponade group with PVR (unpaired students *t* test: $p = 0.026$ and $p = 0.001$, respectively)

underwent scleral buckling, mean BCVA was higher in the temporary tamponade cohort (0.6 ± 0.6) than that of the indefinite tamponade (1.7 ± 0.24). Redetachment occurred in 2/10 (20 %) of patients in the temporary tamponade with a scleral buckle group and 4/9 (44 %) in the indefinite tamponade with a scleral buckle group. This redetachment rate is higher than that of the redetachment rate in both the temporary tamponade (14 %, 4/29) and indefinite tamponade (37 %, 10/27) patients that did not undergo a scleral buckle procedure.

Discussion

With regard to the temporary and indefinite heavy oil tamponade groups discussed in this study, they were not dissimilar at baseline. They had no statistically significant differences in age, BCVA, intraocular pressure, phakic status, PVR rate or rate and number of previous vitreoretinal procedures. At the most recent outpatient visit, there were significant differences between the two groups. The mean final BCVA and rate of ambulatory vision were significantly lower in the indefinite tamponade group. This may be due to several factors including the refractive error induced by the tamponade, the higher subsequent RD rate, variations in lens opacity as well as ocular comorbidities such as maculopathy, keratopathy and glaucoma.

The anatomical reattachment rates of 92.3 % in the temporary tamponade group and 75.0 % in the indefinite tamponade group are within the rates mentioned in the literature (33–86 % persistent attachment following removal of heavy oil tamponade) [7].

Morphis et al. [8] reported the effects of long-term heavy silicone oil upon the eye. Compared to our cohort, this study had a high rate of proliferative diabetic retinopathy (PDR) patients at 42 % and did not include a group of patients with short-term exposure to the heavy oil tamponade. The anatomic success reported in their study (74.0 %) was very similar to that reported in the indefinite tamponade group of our study (75. %). Some of their patients had band keratopathy (8 %) and corneal decompensation (12 %) similar to our cohort. However, they also reported iris rubeosis (14 %), and optic neuropathy (28 %), which were not observed in our patients. This discrepancy may be related to the high rate of PDR in the studied population.

It is not surprising that PVR itself was a significant negative prognostic factor in terms of visual outcome when looking at all patients. The presence of PVR has been and continues to be a major negative prognostic factor in vitreoretinal surgery [11].

The rate of raised IOP was higher in the temporary tamponade group. A rise in IOP was a common indication for removal of the tamponade. All patients in both groups had the IOP controlled with either topical medication or cyclodiode ciliary body ablation. The rates of raised IOP reported here are similar to those reported elsewhere (14–18 %) [7, 8]. It would appear that IOP rise is unlikely to be related to the duration of tamponade. Although a rate of hypotony of up to 10 % has been reported in the literature [8], we did not encounter a case in this cohort.

A patient with a clear cornea may have been more likely to have the tamponade removed, so the reduced corneal complication rate of the temporary tamponade group, should be interpreted in this light. It is also possible that tamponade duration is related to the risk of corneal complications. Similar levels of band keratopathy (8 %) and corneal decompensation (12 %) were reported by Morphis et al. [8].

It is possible that the higher rate of RD and lower BCVA results seen in the patients who had simultaneous scleral buckling surgery at time of oil instillation is related to the complexity of these cases. In the indefinite tamponade group who underwent buckle surgery, 66 %, or six out of the nine patients, had PVR which is similar to the temporary tamponade group, of which 60 %, or six out of ten patients, had evidence of PVR.

An advantage of this study is that it reflects the experience of a single surgeon and a single tamponade agent. However, this study was retrospective and non-randomised; both of these factors limit the interpretation of our results.

This study supports the use of heavy oil tamponade. While it is almost always planned to be a temporary measure, it is reassuring to learn that it is not unreasonable for the eye to tolerate a long-term exposure to heavy oil in those who refuse or are unfit for further surgery. Temporary tamponade patients had better outcomes; however, it is encouraging to see that the majority of indefinite tamponade patients still retained ambulatory vision in the affected eye. Good initial BCVA and absence of PVR are positive prognostic signs in heavy silicone oil tamponade patients, while scleral buckling conferred a higher detachment rate. Uncontrolled IOP was relatively uncommon in both groups and the overall complication rate was low.

Conflict of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Ethical standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

References

1. Wolf S, Schön V, Meier P, Wiedemann P (2003) Silicone oil-RMN3 mixture ("heavy silicone oil") as internal tamponade for complicated retinal detachment. Retina 23(3):335–342
2. Gabel VP, Kampik A, Gabel C, Spiegel D (1987) Silicone oil with high specific gravity for intraocular use. Br J Ophthalmol 71(4):262–267
3. Gremillion CM, Peyman GA, Liu KR, Naguib KS (1990) Fluorosilicone oil in the treatment of retinal detachment. Br J Ophthalmol 74(11):643–646
4. Eckardt C, Schmidt D, Czank M (1990) Intraocular tolerance to silicone oils of different specific gravities. An experimental study. Ophthalmologica 201(3):133–139
5. Ozdek S, Yuksel N, Gurelik G, Hasanreisoglu B (2011) High-density silicone oil as an intraocular tamponade in complex retinal detachments. Can J Ophthalmol 46(1):51–55
6. Rizzo S, Genovesi-ebert F, Vento A, Cresti F, Di bartolo E, Belting C (2007) A new heavy silicone oil (HWS 46-3000) used as a prolonged internal tamponade agent in complicated vitreoretinal surgery: a pilot study. Retina 27(5):613–620
7. Heimann H, Stappler T, Wong D (2008) Heavy tamponade 1: a review of indications, use, and complications. Eye 22(10):1342–1359
8. Morphis G, Irigoyen C, Eleuteri A, Stappler T, Pearce I, Heimann H (2012) Retrospective review of 50 eyes with long-term silicone oil tamponade for more than 12 months. Graefes Arch Clin Exp Ophthalmol 250(5):645–652
9. Lucke KLH (1990) Silicone oil in the treatment of complicate dretinal detachments:techniques, results, and complications. Springer, Berlin, New York
10. Avery RL, Fekrat S, Hawkins BS, Bressler NM (1996) Natural history of subfoveal subretinal hemorrhage in age-related macular degeneration. Retina 16(3):183–189
11. Williamson TH, Shunmugam M, Rodrigues I, Dogramaci M, Lee E (2013) Characteristics of rhegmatogenous retinal detachment and their relationship to visual outcome. Eye 27(9):1063–1069