

# Silicone oil *versus* gas tamponade for giant retinal tear-associated fovea-sparing retinal detachment: a comparison of outcome

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## Abstract

**Purpose** Silicone oil is the most common choice of tamponade agent used when managing a giant retinal tear (GRT). Concern exists regarding its potential detrimental effect on vision. We herein report on visual and surgical outcomes of all patients treated at Moorfields Eye Hospital for a GRT over a five year period. We further analysed a subgroup of fovea-sparing retinal detachments (RD) treated by pars plana vitrectomy (PPV) with either silicone oil or gas tamponade.

**Methods** Retrospective comparative, non-randomised, cross-sectional review of patients with a new diagnosis of GRT from 1 September 2005 to 31 August 2010

**Results** One hundred twenty four eyes of 118 patients were identified with mean age of 45.5 years and median follow-up of 24 months. Subgroup analysis of fovea-sparing RDs (Silicone Oil  $n = 49$ , Gas  $n = 15$ ) revealed visual loss ( $\geq 2$  Snellen Lines of vision) in 49.0% ( $n = 24$ ) of patients managed with oil compared to 13.3% ( $n = 2$ ) of gas patients ( $P = 0.019$ ). In all, 73.3% ( $n = 11$ ) in the gas group achieved a final vision of 6/12 or better, compared to 36.7% ( $n = 18$ ) in the oil group ( $P = 0.031$ ). No difference was observed in eventual or primary anatomical success rate (100 vs 93.9%, and 66.7 vs 79.6%, gas vs oil, respectively, ( $P > 0.1$ )). Postoperative complications were absent in 66.7% ( $n = 10$ ) of gas patients compared with 14.3% ( $n = 7$ ) of oil patients ( $P = 0.002$ ). Multiple variable linear regression determined tamponade choice as the only variable predictive of final visual acuity ( $P = 0.046$ ).

**Conclusion** Eyes with fovea-sparing GRT-related RDs managed with gas achieved a better visual outcome with fewer

postoperative complications and no significant difference in anatomical success. A multicentre approach to investigate this further is advised.

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## Introduction

A giant retinal tear (GRT) is defined as a full thickness retinal break of three or more clock hours in circumference in the presence of a detached posterior hyaloid.<sup>1–3</sup> The incidence of proliferative vitreoretinopathy (PVR) in GRT-related retinal detachments (RDs) is greater than in non-GRT-related RDs, with reported incidences ranging from 11 to 41%, and comparatively poorer associated surgical outcomes.<sup>2,4–11</sup> Globally, silicone oil remains the most widely used tamponade agent when managing GRTs,<sup>5,12–19</sup> employed in up to 85% of cases in the UK.<sup>4</sup> In addition to its well documented side effects, which include glaucoma and keratopathy, concern exists regarding its potential detrimental effect on vision particularly after its removal.<sup>20–25</sup> The mechanism of visual loss on silicone oil removal remains unexplained and is of particular concern in patients whose fovea remains attached.

A small randomized controlled clinical trial comparing the visual and surgical outcomes in patients with a GRT and Grade C proliferative vitreoretinopathy, found no difference between patients treated with silicone oil or perfluoropropane (C<sub>3</sub>F<sub>8</sub>) at 5 years.<sup>26</sup>

This study was undertaken to (a) report on the visual and surgical outcomes of all patients treated at Moorfields Eye Hospital for a GRT over a 5-year period and (b) to compare the

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outcomes of a subgroup of patients with fovea-sparing retinal detachments treated by pars plana vitrectomy and either silicone oil or gas tamponade; this analysis being undertaken to exclude the potential confounding effect of foveal detachment.

### Materials and methods

This study was a retrospective, comparative, non-randomised cross-sectional review. Following local research and management committee approval, a retrospective electronic and paper case note review was performed on all patients who presented to Moorfields Eye Hospital between 1 September 2005 and 31 August 2010 with a new diagnosis of GRT.

Cases were identified using specific electronic search codes or by the documentation of a GRT in electronic patient records consisting of: outpatient clinic records, primary care correspondences and operative records.

Baseline demographic and ocular characteristics, operative management, and visual and surgical outcomes were recorded.

### Statistical methods

Fisher's exact test was used to compare categorised visual and surgical outcome in eyes with fovea-sparing retinal detachments using IBM SPSS Statistics Version 24.0 (IBM, UK Ltd). Visual outcome measures included (a) the proportion of eyes achieving a final vision of  $\geq 6/12$  and (b) the proportion of patients losing two or more lines on the Snellen visual acuity chart when compared to baseline vision. Surgical outcome measures were (a) the proportion of patients achieving eventual anatomical success with the absence of internal tamponade, (b) the proportion of patients achieving primary success with the absence of internal tamponade and (c) the proportion of patients suffering postoperative complications.

Forward stepwise multiple variable linear regression analysis was performed to determine independent baseline variables associated with visual outcome in eyes with fovea-sparing retinal detachments.

### Results

This review included 124 eyes of 118 patients who presented to Moorfields Eye Hospital over the study period with a median follow-up of 24 months (range 2–72 months). Review of notes occurred at least 12 months post GRT repair. Paper or electronic case notes retrieval was achieved for all cases.

### Baseline characteristics

Baseline characteristics are summarised in Table 1. The majority of the cohort were male, with associated trauma reported in approximately one fifth of patients. High myopia was present in approximately one quarter of patients in whom the refractive status was known.

Median presenting vision was 6/24 (range, 6/5—light perception). Approximately 40% of eyes presented with a visual acuity of  $\geq 6/12$  with one third seeing worse than 6/60 at presentation. One quarter of patients were pseudophakic.

Retinal detachment (RD) was present in 92% of eyes at presentation, over half of which (73, 58.9%) were fovea-sparing. Large GRTs ( $> 180^\circ$  degrees) were present in one quarter of eyes, and established PVR (Grade C)<sup>27</sup> was documented in 10% of eyes at presentation.

Visual acuity in the fellow eye was  $> 6/12$  in the majority of patients (89.5%).

### Management

Data regarding the primary management of affected and fellow eyes are summarised in Table 2. Pars plana vitrectomy was the preferred choice of primary

**Table 1** Baseline characteristics at presentation

Characteristics at presentation	N (%)
Eyes	124
Patients	118
Male	106 (89.8)
Mean age (years)	45.5
<i>Predisposing conditions</i>	
Trauma	27 (22)
Myopia $> -6$ DS	33 of 91 (27)
Hereditary Vitreoretinopathies	9 (7.5)
Presenting VA $\geq 6/12$	54 (43.5)
Presenting VA $< 6/60$	40 (32.3)
<i>Lens status</i>	
Phakic (Clear)	71 (57.3)
Cataract	17 (13.7)
Pseudophakic	30 (24.2)
Aphakic	5 (4.0)
Dislocated IOL	1 (0.8)
<i>Retinal detachment</i>	
Fovea attached	73 (58.9)
GRT $\geq 180^\circ$	31 (25.0)
PVR—Grade C	12 (10.0)
<i>Fellow eye</i>	
VA $\geq 6/12$	111 (89.5)
VA $< 6/60$	6 (4.8)
Previous/current GRT	5 (4.0)
Previous/current non-GRT RD	1 (0.8)

Data expressed as *n* (%) of 124 eyes of 118 patients.

**Table 2** Data on primary management of affected and fellow eyes

Management	N (%)
<i>Affected eyes (procedure)</i>	
None	2 (1.6)
Vitrectomy	112 (90.3)
Laser/cryopexy alone	9 (7.3)
CryoBuckle	1 (0.8)
Localised retinopexy	51 of 112 (45.5)
360° Laser retinopexy	60 of 112 (27)
Cryopexy	86 (76.8)
<i>Tamponade</i>	
Silicone oil	94 of 112 (83.9)
Perfluoropropane (C <sub>3</sub> F <sub>8</sub> )	17 of 112 (15.2)
Sulphurhexaflouride (SF <sub>6</sub> )	1 of 112 (0.9)
<i>Fellow eyes (procedures)</i>	
None	103 of 110 (93.6)
360° Treatment	
360° Laser	3 of 110 (2.7)
360° Cryotherapy	0
Local retinopexy/cryopexy	4 of 110 (3.6)

Data expressed as *n* (%) of 124 eyes of 118 patients unless otherwise stated.

management in over 90% of cases. In all, 27% of affected eyes were treated with 360° barrier laser retinopexy, intraoperatively. A small number of cases (*n* = 9) were treated non surgically as there was no concomitant neurosensory detachment. One patient, initially diagnosed as a retinal dialysis, was managed primarily with a scleral buckle and cryopexy with subsequent augmented barrier laser retinopexy. The retina remained attached at 31 months with a documented visual acuity of 6/9.

A total of 110 fellow eyes were eligible for prophylactic treatment at the time of their affected eye GRT. Most fellow eyes were not treated prophylactically (93.6%), with only three eyes treated with 360° prophylaxis and two eyes treated for local pathology. None of these eyes subsequently developed an RD over a median follow-up period of 24 months (range 5–42 months). Nine of 110 fellow eyes detached over the study follow-up period; all occurring within 22 months of their first eye GRT.

**Outcome**

Outcome data were available for 115 out of the 122 treated eyes and is summarized in Table 3. Patients with no outcome data or follow-up of <2 months were excluded. The median follow-up was 24 months with a range from 2 to 72 months. Eventual anatomical success rate was defined as an attached retina in the absence of an internal tamponade agent, and was achieved in 91.3% of eyes. In all, 79.1% of cases were successful at the first

**Table 3** Postoperative outcome of 115 eyes

Postoperative outcome	N (%)
Median follow-up (months)	24
<i>Visual acuity</i>	
≥ 6/12	50 (43.5)
< 6/60	23 (20.0)
<i>Anatomic</i>	
Eventual success	105 (91.3)
Primary success	91 (79.1)
Silicone Oil in situ	4 (3.5)
<i>Postoperative complications</i>	
Cataract (of phakic eyes)	58 of 88 (65.9)
Prolonged raised IOP/Glaucoma	30 (26)
Epiretinal membrane	23 (20)
Uveitis	16 (14)
Fellow Eye RD	9 of 110 (8.2)

Data expressed as *n* (%) of 115 eyes unless otherwise stated.

procedure. The proportion of patients achieving the Driving Vehicle License Association (DVLA) visual standards for driving (≥ 6/12) was 43.5%, with 20% of eyes seeing worse than 6/60 at the time of their final follow-up.

The commonest postoperative complication was cataract, occurring in two thirds of phakic eyes (65.9%). Prolonged elevated intraocular pressure (IOP) or glaucoma was present in one quarter (26.1%) of eyes. Six eyes required filtration or aqueous shunt surgery over the period studied.

**Subgroup analysis of patients with fovea-sparing retinal detachments managed with silicone oil or gas tamponade**

Sixty eight eyes with fovea-sparing retinal detachments and managed by vitrectomy with either gas or silicone oil tamponade were analysed as a subgroup. Surgical and visual outcomes were compared. Table 4 summarizes the baseline characteristics of both groups. Expansile gas was the choice of primary tamponade agent in 16 (23.5%) eyes, and the remaining 52 eyes (77.5%) were managed with silicone oil. Perfluoropropane was the expansile gas of choice in 15 out of the 16 eyes, with sulphurhexaflouride used in one patient. Baseline demographics were similar in terms of age and sex. A median visual acuity of 6/9 was recorded in both groups. There was a higher incidence of high myopia (27.5%), trauma (19.2%), larger (> 180°) GRTs (26.9%) and PVR Grades A or B (11.5%) in eyes managed with silicone oil compared to the gas group where rates were 15.4, 12.5, 6 and 6%, respectively. There were no documented cases of established PVR (Grade C) at baseline in either group. In all, 90.2% of GRTs managed with oil extended inferiorly (ie below 8 or 4 o'clock<sup>28</sup>)

**Table 4** Baseline Characteristics of eyes with fovea-sparing RDs managed by silicone oil or gas tamponade

Baseline characteristics of fovea-sparing retinal detachments	Gas tamponade	Oil tamponade	P Value
Patients	16	52	
Mean age (years)	46.4	45.4	
Males	13 (81.3)	49 (94.2)	
<i>Predisposing conditions</i>			
Trauma	2 (12.5)	10 (19.2)	0.71
Myopia $\geq -6$	2 of 13 (15.4)	11 of 40 (27.5)	0.48
Hereditary vitreoretinopathies	0	5 (9.6)	
<i>Clinical characteristics</i>			
Median presenting VA	6/9	6/9	
<i>Lens Status</i>			
Pseudophakic	5 (31.3)	14 (26.9)	
<i>Retinal detachment</i>			
GRT $>180^\circ$	1 (6)	14 (26.9)	0.1
PVR Grade A or B	1 (6)	6 (11.5)	0.68
Inferior Tear (GRT extends below 4 or 8 o'clock)	5 (33.3)	46 (90.2)	<b>&lt;0.01<sup>a</sup></b>

Data expressed as *n* (%) of 16 eyes in gas group and 52 eyes in oil group unless otherwise specified. <sup>a</sup>Bold type indicates statistical significance.

compared to only one third (33.3%) of those managed with expansile gas ( $P < 0.01$ ).

**Outcome analysis**

Visual and surgical outcomes were available in 15 of the 16 patients in the gas group, and 49 of 52 patients treated with oil. Comparisons between the groups are summarized in Table 5. Vision was categorized into the proportion of patients achieving  $\geq 6/12$  (driving vision), and those patients suffering visual loss (defined as a drop of  $\geq 2$  Snellen lines when comparing final visual acuity to that at presentation). In all, 73% of patients in the gas group achieved driving vision compared to only 37% in the oil group ( $P = 0.0194$ , Fisher's exact). Fewer patients lost vision in the gas group compared to the oil group, 13% and 48%, respectively ( $P = 0.031$ ). Regarding surgical outcomes, there was no statistical difference in the proportion of patients achieving eventual anatomical success, with 100 and 93.9% in the gas and oil group, respectively ( $P > 0.1$ ). Primary success was achieved in 66.7% of patients treated with gas, compared to 79.6% in which oil was used ( $P > 0.1$ ).

Patients in whom silicone oil was used as a primary tamponade agent underwent routine removal at 3–5 months post primary procedure. Seven eyes required further surgery following redetachment after primary oil removal; six of the seven required repeat surgery with oil,

**Table 5** Outcome comparison of eyes with fovea-sparing RDs managed with either gas or oil

Outcome Analysis	Gas tamponade (n = 15)	Oil tamponade (n = 49)	P value
<i>Vision</i>			
$\geq 6/12^*$	11 (73.3)	18 (36.7)	<b>0.031</b>
Vision Loss* (Loss of $\geq 2$ snellen lines)	2 (13.3)	24 (49.0)	<b>0.019</b>
<i>Surgical</i>			
Eventual anatomical success	15 (100)	46 (93.9)	$>0.1$
Number of ops to achieve success:			
1	10 (66.7)	39 (79.6)	$>0.1$
2	3 (20)	5 (10.2)	
3	2 (13.3)	1 (2.0)	
4	0	1 (2.0)	
<i>Complications</i>			
Nil*	10 (66.7)	7 (14.3)	<b>0.002</b>
Cataract (of phakic eyes)	4 of 10 (40)	18 of 35 (51.4)	$>0.1$
Uveitis	2 (13.3)	8 (16.3)	$>0.1$
Prolonged elevated IOP/glaucoma*	1 (6.7)	16 (32.7)	<b>0.047</b>

Data expressed as *n* (%) of 15 eyes in gas group and 49 eyes in oil group unless otherwise stated. Bold type indicates statistical significance. \*Indicates statistical significance.

where one eye re-attached with repeat surgery and perfluoropropane gas. In the gas group, considering the 5 eyes where primary success was not achieved, four required repeat surgery with silicone oil, and one achieved subsequent successful surgery with sulfahexafluoride.

Postoperative complications were absent in 66.7% of gas-treated eyes compared with only 14% in eyes treated with oil ( $P = 0.002$ ).

The aforementioned comparisons may be influenced by a disproportionate weighting of baseline variables associated with poorer outcomes in eyes treated with silicone oil, for example, PVR, larger GRTs ( $>180^\circ$ ), hereditary vitreoretinopathies, inferior tear position. Therefore, adopting final visual acuity (converted from Snellen to LogMAR) as the dependent variable, a forward stepwise multiple variable linear regression analysis was performed including all baseline variables in Table 4. The final model fitted contained tamponade choice as the only independent variable significantly associated with visual outcome ( $P = 0.046$ ).

Unexplained visual loss (defined as a drop of two or more Snellen lines) following oil removal without recovery was observed in 10 patients (20.4%) and was the most common cause of poor visual outcome in the oil group. Advanced glaucomatous optic neuropathy ( $n = 9$ ) was the next most common cause for poor vision in eyes managed with silicone oil.



## Discussion

Baseline characteristics and management data are comparable to recently published reports from a nationwide prospective epidemiological study.<sup>4</sup> Visual and surgical outcomes of patients attending our unit over the 5-year period studied are also similar.<sup>4</sup>

Considering the prophylactic treatment of fellow eyes, there is a clear difference in practice at our institution compared to the rest of the UK. Prophylactic treatment of 360° was performed in only 3 out of 110 (2.7%) eligible cases (2 patients were treated for local pathology) compared to 16 out of 41 (39%) cases nationwide. Comparisons between fellow eye detachment rates are limited by the small numbers observed and the varying duration of follow up. However, allowing for these limitations, the incidence of fellow eye detachments at our institution is low without prophylactic treatment. A recent Cochrane review concluded that there was insufficient evidence and in particular an absence of prospective randomized controlled trials to support or refute fellow eye prophylaxis.<sup>29</sup>

Silicone oil remains the most common choice of tamponade agent when managing GRTs, being used in ~84% in this series. Its proponents advocate its use primarily because of the higher reported incidence of PVR, in addition to a perceived reduction of intraoperative slippage. Alternate tamponade agents including intraocular gas and perfluoro-*n*-octane<sup>30</sup> have been utilized with reported good visual outcomes.<sup>10</sup>

Two large prospective studies published PVR incidences of 38.2%<sup>9</sup> and 40.7%.<sup>6</sup>

In our series, we observed a 10.0% incidence of established PVR (Grade C<sup>27</sup>) at presentation and this rate is similar to that recently reported in the UK epidemiology study (11.3%).<sup>4</sup> The overall observed rate of established PVR over the period studied was 16.9%, with a proportion of patients subsequently developing 'new' PVR at RD recurrence. Our data, along with that most recently reported, suggests a lower rate of proliferative vitreoretinopathy associated with GRTs. This finding questions the necessity to use silicone oil when the strength of its use has been predicated on high associated PVR rates.

Our study supports this move away from silicone oil, particularly in eyes with fovea-sparing detachments. Patients managed with gas tamponade achieved a better visual outcome with fewer complications. There was no significant difference in anatomical success rate, nor was there a difference in the number of procedures to achieve success. Although there was trend towards a lower primary success rate in the gas group (66.7 vs 79.6%) this was not statistically significant.

The observed difference in visual outcome is interesting. 11 of 15 patients (73.3%) managed with gas achieved a final visual of acuity of 6/12 compared to only

18 of 49 (36.7%) in the oil group. The commonest cause of poor vision in eyes managed with oil was unexplained visual loss upon its removal and accounted for 10 of 49 eyes (20.4%). This phenomenon, originally reported in 2004,<sup>20</sup> remains a concern and further supports a move away from using oil in fovea-sparing GRTs. A recently published study by authors in our group estimated the overall incidence of unexplained visual loss with silicone oil to be 3.3%, with a markedly higher incidence observed in fovea-sparing GRTs.<sup>25</sup> This is in keeping with the findings of this study involving larger numbers over a longer follow-up period.

We acknowledge limitations of this retrospective review. Analyses were performed to adjust for baseline variables potentially associated with visual outcome, and only the tamponade choice achieved statistical significance. However, this does not account for eyes where decisions to use oil were made purely on the basis of intraoperative findings (eg, retinal slippage), although we would expect this number to be small.

The risk of retinal slippage can be minimised using silicone oil<sup>31</sup> or perfluorocarbon liquid<sup>10</sup> for tamponade as an intraoperative air exchange can be avoided. This step is unavoidable when using gas and is therefore an obvious disadvantage, particularly in larger tears.

Additionally, there was a significant disproportionate number of GRTs extending inferiorly (between 4 and 8 o'clock) in the oil group compared to the gas group; 33.3 vs 90.2%. This limits our ability to extrapolate our findings to include GRTs of any position in this study although interestingly it was not a statistically significant variable in the multiple variable regression analysis

In order to corroborate the observed beneficial effect of gas tamponade in fovea-sparing RDs, a prospective randomized controlled clinical trial appears justified. In the interim, we have generally moved away from the routine use of silicone oil towards expansile gas as post-operative tamponade in the management of GRT. We would recommend a multicentre approach to investigate this further.

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## Summary

### What was known before

- Silicone Oil is the most commonly used tamponade agent for managing giant retinal tears (GRT).

### What this study adds

- GRT-related fovea-sparing retinal detachments managed with gas tamponade achieved a significantly better visual outcome with fewer complications and no statistically significant difference in anatomical outcome.
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## Conflict of interest

The authors declare no conflict of interest.

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