

## Original Article

# A retrospective study on the Maltese population of the outcome of retinal detachment repair after the removal of silicone oil

Matthew T. Fenech, Thomas Fenech, James G. Diamond

## Abstract

**Background:** Silicone oils of different viscosities are used in the treatment of retinal detachments of varying pathology.

**Method:** Seventy-two cases of retinal detachments managed with silicone oil were reviewed in a retrospective chart analyses. Eighty nine patients were reviewed from which data on primary pathology, type of silicone oil, duration of oil “in situ” and complications (including emulsification, increased intraocular pressure (IOP), re-detachment, cataract and presence of CME) were compiled. Of this number, 72 patients with post-operative follow-up of two years or more and documentation of the above parameters were included. The data was carefully analysed in an effort to determine the primary factor or factors of the varying silicone oil substitutes utilized responsible for the successful or non-successful re-attachment of the retina.

**Results:** Retinal re-detachment rate is greater when Silicone Oil (SO) is removed before 12 months. Complex vs non-complex retinal re-detachments in sub-group analysis indicates superiority of retention of SO for greater than 12 months. Emulsification is greater in low viscosity SO (1300cts).

**Conclusion:** The complication rates witnessed in this retrospective study are comparable to the findings of published studies present in the ophthalmic literature on an international scale. The findings of this study support the hypothesis that it is the duration of the SO “in situ” as opposed to the viscosity or other SO attributes which ultimately influences the re-detachment rate.

## Keywords

Silicone Oil, Retinal Detachment, Emulsification, Intra-ocular pressure, Re-detachment

## Introduction

Retinal detachment is the separation of the neurosensory retina from the underlying retinal pigment epithelium (RPE). Retinal detachment repair was first described in 1920 by Gonin, and has since undergone several advancements.<sup>1</sup> The ultimate success of re-attachment is dependent on sealing any breaks in the retina and ensuring there is no longer any traction between the vitreous and retina itself. Uncomplicated rhegmatogenous retinal detachments may be treated through a number of modalities, the likes of which include pneumatic retinopexy, scleral buckling and pars plana vitrectomy.<sup>2-3</sup> Advancements in vitrectomy techniques coupled with the introduction of silicone oil have allowed for the treatment of more complicated retinal reattachments, resulting in higher success rates and lower rates of re-detachment.

Introduction of heavy silicone oil (HSO),

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namely Densiron 68, has allowed for the management of inferior tears and recurrent re-detachments due to its physical properties, allowing it to tamponade lower tears due to its greater specific gravity when compared to water.<sup>4-5</sup> It is the purpose of this study to determine the complications associated with retinal detachment repair managed with silicone oil at Mater Dei Hospital, Malta, Europe, when compared to the results of similar studies on an international level. We also aim to demonstrate our hypothesis that it is the duration of silicone oil “in situ” rather than the viscosity or other attributes of silicone oil which ultimately influences the rate of re-detachment.

### Materials and Methods

SO with viscosities of Oxane1300cts, Oxane5000cts, Oxane5700cts and Densiron 68 (Heavy Silicone Oil {HSO}) were utilised as a vitreous substitute in 89 cases of retinal detachment. Seventeen patients were excluded because of lack of comparative data.

Seventy-two (72) cases of retinal detachments were used for the purpose of this study. Twenty-six patients fell into the rhegmatogenous retinal detachments (RRD) group, while the diabetic tractional retinal detachments (DTRD) and complex retinal detachments (CRD) groups included nineteen and twenty-seven patients respectively.

Patients suffering from multiple retinal tears, proliferative vitreoretinopathy and large inferior retinal tears were included within the CRD group.

The study was approved by the appropriate patient safety and ethics approval boards. Strict inclusion and exclusion criteria were established. The surgical register at Mater Dei Hospital Malta was used as the source of all the data for surgical patients undergoing retinal detachment repair. Data of procedures performed by the same consultant vitreoretinal surgeon between the years 2007 and 2013 was used. Eighty nine (89) patients were reviewed from which data on primary pathology, type of SO, duration of oil “in situ” and complications (including emulsification, increased intraocular pressure (IOP), re-detachment, cataract and presence of CME) were compiled. Of this number, seventy two (72) patients with post operative follow-up of two years or more and documentation of the above parameters were included in this study.

Patients in which 5000cts and 5700cts SO was used were grouped together in view of the fact that the structural make up was essentially identical (Table 1).

The data was carefully analysed in an effort to determine the primary factor or factors responsible for the successful or non-successful re-attachment of the retina.

*Table 1: Representation of the various silicone oils used and their individual properties*

Properties of Silicone Oils				
Oil	Density (g/cm <sup>3</sup> )	Viscosity (mPa.s)	Surface Tension (mN-m)	Refractive Index
Oxane1300	0.98	1000	44.9	1.4
Oxane5000	0.975	5000	43.01	1.4035
Oxane5700	0.98	5000	44.9	1.4
Densiron 68 - HSO	1.06	1500	40.82	1.387

### Results

Retinal re-detachment rate is greater when SO is removed before 12 months (Table 2). The overall re-detachment rate in this series was 26.4%. SO “in situ” for 12 months or less resulted in a re-detachment rate of 18.1% and a re-detachment rate of 8.3% for all cases where SO was present for greater than 12 months (Table 2). Of the complex

cases, 61.5% re-detached when SO was left “in situ” for less than 12 months and 38.5% re-detached when SO was “in situ” for greater than 12 months (Table 3). Of the non-complex cases, 83.3% re-detached on removal of SO at less than 12 months and 16.7% re-detached when SO was retained for longer than 12 months (Table 3).

Complex vs non-complex retinal re-

detachments in sub-group analysis indicated the superiority of retention of SO for greater than 12 months (Table 3). Complex cases making use of 1300cts SO had a re-detachment rate of 15.4% when kept “in situ” for less than 12 months compared to a re-detachment rate 7.7% when retained for longer than 12 months (Table 3).

5000/5700 and Heavy SO however had a re-detachment rate of 46.2% when retained for less than 12 months and 30.8% when longer than 12 months (Table 3). Furthermore, separation into presence or absence of PVR supports the recognised poor success rate of re-attachment in cases of severe PVR (Tables 4).

**Table 2:** Representation of the various silicone oils used, their re-detachment rates and the time in situ.

<b>Retinal Re-Detachment vs Duration Silicone Oil "in situ"</b>			
Silicone Oil	#Pts	Duration of Oil in Situ	
		<12Mo	>12Mo
1300 cts	34	2	1
5000/5700 cts	31	9	5
Densiron 58 - HSO	7	2	0
<b>Total</b>	72	13	6
<b>Total Percent</b>		<b>18.1</b>	<b>8.3</b>

**Table 3:** Sub-analyses of the re-detachment rate of complex and non-complex cases per silicone oil used separated in a period of < or > 12. This shows a greater rate of detachments in the period less than 12 months irrespective of whether the detachment was complex or non-complex

<b>Retinal Re-detachment vs Duration Silicone Oil "in situ"</b>				
<b>Sub-set Analysis</b>				
Silicone Oil	Complex RD		Non-Complex RD	
	<12Mo	>12Mo	<12Mo	>12Mo
1300 cts	2	1	0	0
5000/5700 cts	5	4	4	1
Densiron 58 - HSO	1	0	1	0
<b>Sub-total</b>	8	5	5	1
<b>Total</b>	13		6	
<b>Total Percent</b>	<b>61.5</b>	38.5	<b>83.3</b>	16.7

**Table 4:** Sub-group analyses showing presence of PVR primary cause for decreased detachment rate in complex group

Complex RD +/- PVR					
Pathology	Silicone Oil	#Pts		% Attached	% Detached
Complex RD +PVR	1300	9	4	69.2	30.8
	50/57	5	6	45.5	54.5
	Heavy	2	1	66.7	33.3
<b>Group Total</b>		16	11	<b>59.3</b>	<b>40.7</b>
Complex RD - PVR	1300	9	1	90	10
	50/57	5	2	71	29
	Heavy	2	0	100	0
<b>Group Total</b>		16	3	<b>84.2</b>	<b>15.8</b>

Total emulsification rate in the series was 18.1%. Emulsification is greater with low viscosity SO (1300cts) resulting in minimal consequences. 1300cts SO retained for less than 12 months accounted for 15.4% of emulsification cases and 53.8% of cases if retained for longer than 12 months. 5000/5700 and Heavy SO accounted for 7.7% of emulsification cases when retained for less than 12 months and 23.1% when retained for longer than 12 months.

Total increased IOP rate in the series was 30.6%. Increased IOP is greater with 5000/5700 cts Silicone oil as opposed to 1300cts. 1300cts accounted for 36.4% of cases of increased IOP when retained for less than 12 months and 4.6% when “in situ” for longer than 12 months. 5000/5700 and Heavy SO “in situ” accounted for 18.1% of increased IOP cases when retained for less than 12 months and 40.9% when retained for longer than 12.

## Discussion

Silicone oil is a non-expandable clear fluid, commonly used in the treatment of retinal detachment, providing a safe, inert medium to provide endotamponade.<sup>6</sup> Silicone oil has served as a vitreous substitute for many years. Numerous studies have been performed to identify the beneficial effects of silicone oil tamponade whilst also establishing the chemical and physiological properties which may be applied to different clinical scenarios.

Silicone oil management is not without complications. One of the most commonly seen complications with the use of silicone oil is emulsification.<sup>7</sup> Emulsification rates usually vary from anything between 17.2% - 38.4% from the literature reviewed, occurring in 18.1% of patients within our series.<sup>8</sup> Emulsification may occur between 5 months to anything up to 24months, usually occurring within the 1<sup>st</sup> year or so.<sup>9</sup>

Emulsification in itself is clinically significant because of the structural and physiological implications it has on the functioning of the eye. Emulsification refers to the inability of small bubbles to coalesce into larger bubbles after dispersion from the main silicone oil body has occurred. Such a phenomenon results from the alteration in oil surface tension, changes in oil viscosity as well as prolonged duration of said oil “in situ.” Intrinsic surfactants such as fibrin, fibrinogen and serum, resulting from intra-ocular manipulation, cause a decrease in surface tension, resulting in increased droplet dispersion and ultimately increased emulsification.<sup>10-12</sup> Several studies have also shown that less viscous silicone oils emulsify faster than oils with greater viscosities. Our series demonstrates that the highest rate of silicone oil emulsification was also seen in the 1300cts group, comprising 69.1% of all cases of emulsification.

When selecting silicone oil, one must balance the benefits of prolonged tamponade with the risks posed by emulsification of the oil itself. While low

viscosity silicone oils are usually selected because they are easier to handle surgically being easier and faster to inject and remove via a small-gauge system, higher viscosity silicone oils are subject to decreased and delayed emulsification.<sup>13</sup> Results from our study reveal that 69.2% of all cases of emulsification occurred when using 1300cts SO, with the rest of the cases being distributed amongst SO of greater viscosities. It may hence be argued that SO of greater viscosity results in longer lasting tamponade, secondary to delayed rate of emulsification, which is why they are more commonly used in cases of complex retinal detachment.

Although surface tension and viscosity influence the rate of emulsification, it is the duration of silicone oil “in situ” which has the strongest influence on the occurrence of emulsification.<sup>14</sup> Emulsification may occur between 5 months to anything up to 24 months, usually occurring within the 1<sup>st</sup> year or so. Results from our series reveal that 23.1% of all cases of emulsification occurred before 12 months of SO “in situ”, while 76.9% of cases occurred when SO was retained for greater than 12 months. That being said, it should be noted that silicone oils of various viscosities have similar tamponading effects as long as emulsification of the oil has not taken place.<sup>15-16</sup>

From conclusions made in our study, the rate of re-detachments is significantly increased if silicone oil is removed before 12 months. Unfortunately, most surgeons insist on retaining SO for no longer than 12 months, in an attempt to reduce complications associated with SO “in situ”, one of which includes emulsification.

Another commonly faced complication associated with the use of SO is the fluctuation of intra-ocular pressure (IOP). IOP was increased in 30.6% of all patients within this series with 54.5% of cases being in patients where SO was retained for less than 12 months and 45.5% of cases where SO was “in situ” for greater than 12 months. Our values are greater than average values in other studies, which range from 1.5% to 27.7%.<sup>17</sup> Although SO with greater viscosity are more likely to result in increases in IOP, no statistical difference was seen with the patients in our series.

The benefits of silicone oil extraction must be outweighed by the risk of retinal re-detachment. The results of this study regarding the similarity of various SO viscosities in retinal re-attachment rates

are comparable to the findings of published studies present in the ophthalmic literature on an international scale. The overall re-detachment rate in our series was that of 26.4%, comparable to a similar study by Soheilein et.al, quoting a re-detachment rate of 28%.<sup>18</sup> That being said, retinal re-detachment rates are quoted in the literature to vary anywhere between 9% and 34%, with such discrepancies being due to the number of patients studied or the underlying disease.<sup>19</sup>

The findings of this limited retrospective study support the hypothesis that it is the duration of the SO “in situ” as opposed to the viscosity or other SO attributes which influences the re-detachment rate. Our findings support that a minimum period of 12 months for SO retention “in situ” is associated with a higher rate of re-attachment. In a similar study by Falkner et.al, it was felt that after a period of 3-6 months, the chances of retinal re-detachment after silicone oil removal were minimal.<sup>20</sup> While this may hold some ground, our findings push us to postulate that a period 12 months or more reduce the rates of re-detachment significantly.

It is interesting to note that whilst most studies in the literature have shown no real difference between the tamponading effects of silicone oils of varying viscosities, our limited study highlights a significantly higher re-detachment rate in the 5000cts silicone oil when compared to other viscosities used. Also of note is that complex retinal re-detachment case success is similar to other categories when PVR is excluded (Table 4). Comparable results were also obtained by Mazareei et.al, where higher rates of re-detachments were found in the rhegmatogenous retinal detachment group with PVR treated with 5000cts silicone oil.<sup>21</sup> Such findings suggest that the higher re-detachment rate in the 5000cts group was not due to the viscosity of the oil itself, but due to the underlying complex pathology for which 5000cts oil is used, where residual traction and re-development of proliferative vitreoretinopathy could have led to re-opening or formation of new retinal breaks and the ultimate re-detachment.<sup>22-23</sup>

The ultimate goal for all retinal surgeons is to establish a stable, re-attached retina, free from any risk factors that may promote its re-detachment. Whilst the possibility of this may be increased by silicone oil with greater viscosity, this must be balanced by the greater risk of failure within that

sub group.

### Acknowledgements

This paper is done in conjunction with the University of Malta Medical School, Malta Europe, Tulane University Medical School and Department of Ophthalmology New Orleans, LA and the Veterans Administration Hospital New Orleans, LA.

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