Research Article

The anatomical success of treating rhegmatogenous retinal detachment with silicone oil compared to gas tamponade

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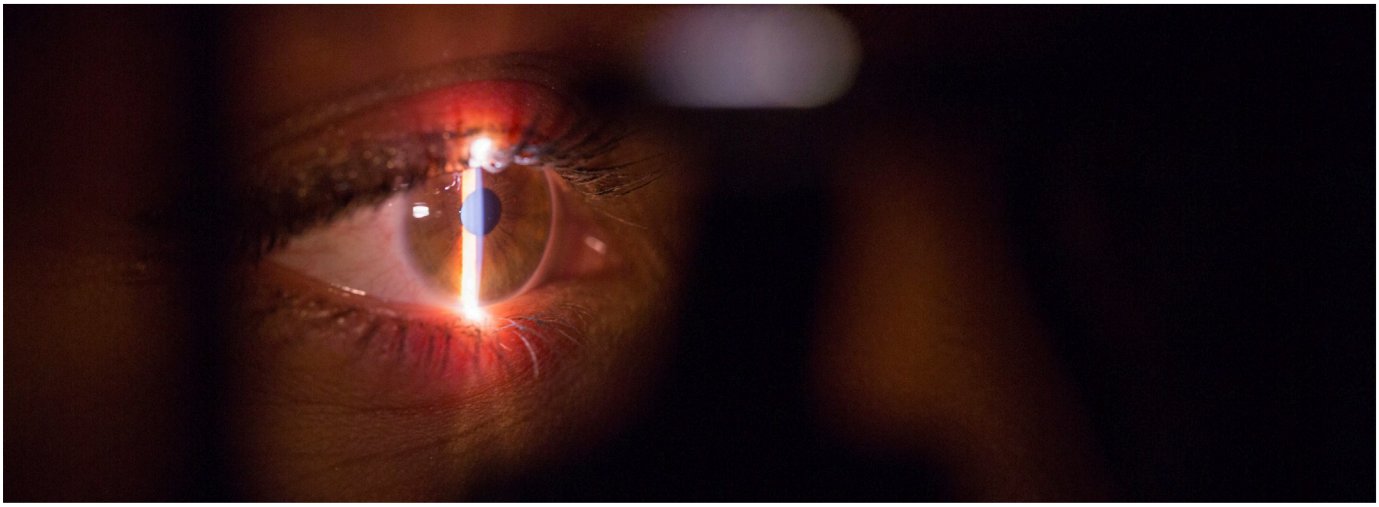

Abstract

Introduction Silicone oil and gas are used as internal tamponades via pars plana vitrectomy for the treatment of rhegmatogenous retinal detachment. The success of retinal reattachment is of primary interest as it forms the foundation for visual outcomes post-operatively. Thus, the aim of this paper is to determine which of these interventions most reliably leads to anatomical success.

Methods PubMed was the main database used to search the literature, in conjunction with Google Scholar. The results of the searches were further examined if they met the selection criteria for this review.

Results The method used yielded three RCTs and one retrospective cohort study. Three of these papers provided information that supported the use of gas tamponade; however, there was conflicting evidence within these studies. Although these investigations found that gas tamponade achieved greater rates of anatomical success, this was not statistically significant for complete retinal attachment or if the eye had not undergone previous vitrectomy. Another study also found that more surgeries had to be undertaken with gas tamponade compared with silicone oil before anatomical success was achieved.

Conclusion The results provided limited and conflicting evidence as to which tamponade would lead to greatest anatomical success. Recommendations would be to perform larger studies, using eyes with similar baseline characteristics before being randomised to either silicone oil or gas tamponade. Providing a long-term follow up of results would also provide greater insight into prolonged anatomical success between the two interventions.

Abbreviations

PPV - Pars plana vitrectomy
RCT - Randomised control trial
RD - Retinal detachment
RRD - Rhegmatogenous retinal detachment
SO - Silicone oil

Introduction

Retinal detachment (RD) is described as the "separation of the neurosensory retina from the underlying retinal pigment epithelium".[1] RD can be classified as either rhegmatogenous, tractional or exudative.[2] Tractional RD is caused by progressive contraction against the retina, most commonly due to proliferative diabetic retinopathy.[2] Exudative RD is rare; it is mostly caused by tumours of the choroid and occurs when subretinal fluid leaks due to the outer blood-retinal barrier becoming damaged.[2] In this paper, the focus is rhegmatogenous RD (RRD), in which intraocular fluid accumulates in the subretinal space due to a retinal break.[3]

> *RRD affects around 1 in 10,000 individuals annually, affecting mainly males as well as individuals with high myopia, or those who have experienced blunt trauma.*[3,4]

RRDs can be treated via pars plana vitrectomy (PPV) with the use of either silicone oil (SO) or gas tamponade.[5] This is achieved by making 1mm cuts in the sclera to gain access to the vitreous humour, which

is removed via suction.[6] The vitreous is then replaced with either a gas bubble (which naturally absorbs within two weeks) or SO, which is removed at a later date.[6]

When deciding upon the type of tamponade medium for RRD, anatomical success (defined as successful reattachment of the retina in the absence of an intraocular tamponade) is of primary interest, as this forms the foundation for visual outcomes post-treatment. Thus, the aim of this paper is to compare the anatomical success between SO and gas tamponade when treating RRD.

Method

A PubMed search was conducted using the search terms, "(Rhegmatogenous Retinal Detachment) AND (Silicone Oil) OR (Gas Tamponade) AND (Anatomical Success)". Eligibility of retrieved literature for analysis was determined through screening against pre-determined inclusion and exclusion criteria **(Table 1)**. The same search was conducted through the Cochrane Library, but no new relevant information was retrieved. Further information was collected via Google Scholar, using the same search terms to obtain general information with regards to RRD and its current treatment options. Searches were carried out in November 2019 to February 2020.

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Comparison of SO and gas tamponade via PPV.	Any comparison to scleral buckle as a treatment.
Using eyes which had RRD.	Using eyes which had macula holes.
Using eyes which had RRD with no specific or exclusive pathological cause.	Using eyes which had RRD specifically and exclusively caused by pathological diseases, such as HIV and/or diabetes.
Results related to the anatomical success of using SO and gas tamponade via PPV.	Using eyes that had undergone recurrent RRD before the study was performed.
Papers published in English language.	Interventions that used a mixture of gas and oil as one tamponade.

Results

Initial searches retrieved 261 articles for analysis. After screening against the pre-determined eligibility criteria, only four studies were identified for qualitative analysis. The papers analysed consisted of three randomised control trials (RCTs)[7-9] and a retrospective cohort study **(Table 2)**.[10]

Three papers provided evidence which favoured the use of gas tamponade. In one of the RCTs,[9] complete retinal attachment was achieved in 73% of eyes using gas and 64% using oil, but the difference was not statistically significant. Despite this, the same study found that gas tamponade achieved better complete posterior retinal re-attachment with a success rate of 83% with gas versus 60% with oil (p=0.045).

Furthermore, in another RCT conducted by Abrams *et al.*,[8] it was also shown that, on eyes that had undergone previous vitrectomy, gas treatment had a significantly higher rate of complete retinal reattachment at 18-36 months (p<0.05). However, for eyes without previous vitrectomy, macular attachment was maintained in all eyes with no differences between SO- and gas-treated eyes.

In addition, the retrospective cohort study by Banerjee *et al.*[10] found that eventual anatomical success was 100% with gas (15 eyes treated) and 93.9% with SO (49 eyes treated). However, it should be noted that this finding was not statistically significant. In addition, four of the eyes treated with gas had to undergo repeat PPV with SO and one eye required repeat gas tamponade before anatomical success was achieved.

However, in the RCT by Hammer *et al.*,[7] the chance of successful reattachment was 50% greater with SO as opposed to gas, but this was not statistically significant. In this study, 18 eyes were treated with SO and 16 with gas tamponade.

Discussion

> *The results provided limited and conflicting evidence as to which tamponade medium is best to treat RRD.*

Although the RCT by Hammer *et al.*[7] suggested that SO was more successful, the small sample size used reduces the power of this study.
In addition, Banerjee *et al.*[10] demonstrated that more of the gas-treated eyes had to undergo repeat PPV, which arguably diminishes the marginal difference in eventual anatomical success between the two interventions. This difference may also be attributed to the fact that 14 of the eyes treated with SO had a more severe retinal tear of >180 degrees, whereas only one of the eyes treated with gas had this baseline characteristic. Furthermore, an additional 34 eyes were treated with SO. Given the larger sample size, the likelihood of achieving 100% eventual anatomical success is understandably reduced.

However, of interest was the study carried out by Abrams *et al.*,[8] which had a sample size of 265 eyes and an almost equal ratio of eyes treated with gas to SO tamponade (gas, n=121 eyes; SO, n=128 eyes).

> *The study findings suggested that gas was more successful at producing long-term retinal re-attachment.*

However, despite the large sample size and randomised design, the findings from one investigation alone cannot be relied upon. However, it can be argued that the remaining RCT[9] provides sufficient and reliable evidence that supports the use of gas tamponade, particularly in favour of posterior retinal reattachment. With this study being performed by the Silicon Study Group (a collaborative group of authors) these results are likely to be of great scientific robustness.

In conclusion, although the studies suggest that gas tamponade is better than SO in treating RRD, more data needs to be collected. The current cohort sizes are simply too small to make any direct links between experimental findings and the general population. It is also important to note that the studies[8,9] of greatest power, due to their large sample sizes and randomised design, were completed in the 1990s. It is possible that surgical techniques have progressed to provide improved outcomes, which could alter the results. Furthermore, as previously mentioned, SO seems to be used for more severe RRD, which could result in less successful outcomes for SO-treated eyes due to a worse baseline pre-intervention. Thus, future studies should aim to use larger cohort sizes with eyes of equal RRD severity to ensure that baseline characteristics are as similar as possible before randomisation to either gas or SO treatment. In addition, longer follow-up periods would allow monitoring of long-term differences in choice of tamponade medium.

It may also be of interest to evaluate how length of SO tamponade and SO removal affects eventual anatomical success. However, one would assume that the longer a tamponade is left in, the greater the chance of anatomical success. Thus, there may be significant ethical limitations surrounding short-term use of SO tamponade.

Table 2. Summary of included papers.

Author (date published)	Title	Study Design	Number of eyes tested	Summary of results
Silicon Study Group (1992)	Vitrectomy with silicone oil or perfluoropropane gas in eyes with severe proliferative vitreoretinopathy: results of a randomized clinical trial. Silicone Study Report 2	RCT	265	Gas tamponade was more likely to achieve retinal reattachment in comparison to SO, but this was not statistically significant. However, complete posterior retinal reattachment was more successful with the use of gas tamponade, which was statistically significant in comparison to SO.
Abrams *et al*. (1997)	Vitrectomy with silicone oil or long-acting gas in eyes with severe proliferative vitreoretinopathy: results of additional and long-term follow-up. Silicone Study report 11	RCT	265	On eyes which had undergone previous vitrectomy, gas treated eyes had a higher rate of complete retinal reattachment, which was statistically significant. However, differences in macula attachment were not statistically significant in eyes which had no previous vitrectomy.
Banerjee *et al*. (2017)	Silicone oil versus gas tamponade for giant retinal tear-associated fovea-sparing retinal detachment: a comparison of outcome	Retrospective cohort study	64	Anatomical success was greater in gas treated eyes than SO, but this was not statistically significant. In addition, five gas treated eyes had to undergo one repeat surgery.
Hammer *et al*. (1997)	Complex retinal detachment treated with silicone oil or sulfur hexafluoride gas: a randomized clinical trial	RCT	34	Chance of successful retinal reattachment was 50% greater with SO tamponade as opposed to gas, but this was not statistically significant.

In addition, research into how different types of gas (e.g., sulphur hexafluoride, perfluoropropane or octofluropropane) affect anatomical success could be beneficial, as the studies included here used a range of different gases which may have contributed to differences in results.

Finally, all the studies examined here randomised more eyes to SO than gas tamponade, but the reasons for this were not addressed. Thus, it may be of interest to perform both a quantitative and qualitative study to determine the proportion of eyes treated with SO tamponade for RRD and factors influencing why SO was used by the surgeon. From this, further studies can be performed to justify or contradict surgical choices.

Contribution Statement The retrieval, screening, analysis and conclusions drawn from the studies selected were undertaken by the author. This article has undergone several revisions via the peer review and copy-editing process, and the final draft has been approved for inclusion in Inspire.

References

1. Kang HK, Luff AJ. Management of retinal detachment: a guide for non-ophthalmologists. BMJ (Clinical research ed), 2008; 336(7655):1235-40.
2. Khalil M, Kouli O. The Duke Elder Exam of ophthalmology: a comprehensive guide for success. CRC Press; 2020. p. 227.
3. Veith M, Stranak Z, Pencak M, et al. 25-gauge vitrectomy and gas for the management of rhegmatogenous retinal detachment. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub, 2019;163(1):80-4.
4. Ghosh YK, Banerjee S, Savant V, et al. Surgical treatment and outcome of patients with giant retinal tears. Eye (Lond). 2004;18(10):996-1000.
5. Lin T, Mieler WF. Management of Primary Rhegmatogenous RD: Review of Ophthalmology; 2008 [Available from: www.reviewofophthalmology.com/article/management-of-primary-rhegmatogenous-rd. Accessed: 26 February 2020.
6. Turner R. Vitrectomy. Information for patients.: Oxford Radcliffe Hospitals NHS Trust; 2009. p. 8.
7. Hammer M, Margo CE, Grizzard WS. Complex retinal detachment treated with silicone oil or sulfur hexafluoride gas: a randomized clinical trial. Ophthalmic Surg Lasers. 1997;28(11):926-31.
8. Abrams GW, Azen SP, McCuen BW, et al. Vitrectomy with silicone oil or long-acting gas in eyes with severe proliferative vitreoretinopathy: results of additional and long-term follow-up. Silicone Study report 11. Arch Ophthalmol. 1997;115(3):335-44.
9. Vitrectomy with silicone oil or perfluoropropane gas in eyes with severe proliferative vitreoretinopathy: results of a randomized clinical trial. Silicone Study Report 2. Arch Ophthalmol. 1992;110(6):780-92.
10. Banerjee PJ, Chandra A, Petrou P, Charteris DG. Silicone oil versus gas tamponade for giant retinal tear-associated fovea-sparing retinal detachment: a comparison of outcome. Eye (London, England). 2017;31(9):1302-7.