

A four-year retrospective surgical case series examining postoperative complications following removal of silicone oil (ROSO) scored using the Complications in Retinal Detachment Surgery (CORDS) Severity Classification Tool

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Abstract

Purpose

Silicone oil (SO) tamponade and the removal of silicone oil (ROSO) in the management of complex retinal detachments carry well-defined postoperative complications. Our objective was to classify and grade complications following ROSO using the Complications of Retinal Detachment Surgery (CORDS) Severity Classification and to propose a unifying global complication score.

Methods

A single-centre retrospective case series of eyes undergoing ROSO was performed between 2018–2022. All patient data was collected with one-year follow-up. Best recorded visual acuity (BRVA, LogMAR), intraocular pressure (IOP, mmHg) and complications were recorded from electronic patient records (EPR). Complications were scored using the CORDS Severity Classification. A Modified Global Complication Score (MGCS) was calculated for our study cohort.

Results

SO was removed from 46 eyes with a mean tamponade duration of 8.2 ± 6.61 months. A total of 88 CORDS items were recorded over the 12-months. Serious complications included anterior displacement of SO (12.5%), retinal re-detachment (5.68%), raised IOP requiring treatment (14.8%), severe loss of vision (18.9%), corneal decompensation (5.68%) and phthisis (2.27%). There was a statistically significant difference in mean severity scores across follow-up timepoints ($F[3,44]=3.06$, $P=0.04$) with a difference observed between the '3-month' and '6-month' timepoints (mean difference +7.71, 95%CI +0.470 to +15.0, $P=0.03$). The MGCS was 9.52% for our cohort.

Conclusion

Postoperative complications following ROSO are common with high-severity complications, such as secondary glaucoma, corneal decompensation and phthisis, emerging after six months. The MGCS provides a single unifying global score that sets a benchmark for comparison between future retinal studies.

KEY MESSAGE

1. Silicone oil tamponade and its removal carry inherent complication risks, yet systematic and standardised reporting of these complications remains lacking across the field.
2. This study applies the Complications in Retinal Detachment Surgery (CORDS) Severity Classification Tool to a retrospective case series of removal of silicone oil (ROSO), demonstrating its practical utility in audit settings and contributing new evidence on associated complications, including unexplained vision loss.

3. A Modified Global Complication Score (MGCS) is proposed as a single unifying figure to summarise complication data, providing a benchmark to facilitate comparison between future studies using the CORDS Severity Classification.
4. Standardised complication reporting tools should be adopted in future vitreoretinal research and retrospective analysis, supporting national efforts to investigate unexplained vision loss following ROSO and enabling more consistent reporting of complications across vitreoretinal surgery studies.

INTRODUCTION

Silicone oil (SO), introduced in the 1960s, is widely used in the management of complex retinal detachments (RD) [1]. The advantages include biochemical inertness, optical clarity, prolonged tamponade duration, reduced retinal slippage, and upright posturing [2–4]. Despite these advantages, removal of silicone oil (ROSO) is advised to prevent long-term complications,[5–10] although optimal timing still remains debated [4, 6, 7, 10]. Long-term SO tamponade is associated with numerous complications, including the progression of cataracts in phakic eyes, secondary glaucoma, band keratopathy, retinal re-detachment, and fibrotic retinal proliferations [4, 11–14]. These arise from SO-induced toxicity, which promotes a pro-inflammatory ocular state [12], emulsified droplet migration [13], corneal endothelium deposition [14], and impaired lens metabolism [15]. ROSO harbours other complications, including the risk of retinal re-detachment, hypotony and unexplained vision loss [16–18]. The mechanism behind these complications still remain unclear, with ongoing investigations into phototoxicity, ionic imbalances, and retinal hypoperfusion [19, 20].

Postoperative complication reporting in vitreoretinal surgery remains non-standardised. Most studies selectively report complications that are judged to be relevant, ignore complications of lesser magnitude, and fail to provide any scoring of complication severity [21–23]. While other surgical fields adopted complication scoring systems decades ago [24–26], vitreoretinal surgery has only recently had landmark work develop a consensus-derived complication scoring tool: the Complications of Retinal Detachment Surgery (CORDS) Severity Classification [22]. Standardised reporting allows for better comparison of complications across studies, transparency in surgical outcomes and tailored patient care. This study aims to apply the CORDS Severity Classification to a retrospective ROSO case series and introduce a single unifying complication score to summarise the complication data. This case series has been reported in line with the PROCESS guidelines [27].

METHODS

Participants

This was a four-year single-centre retrospective review of eyes undergoing ROSO. All patient data was collected from the electronic patient record (EPR) software MediSIGHT (Heidelberg Engineering Group, Germany). This was a cohort of patients shared between two operating vitreoretinal surgeons at a single

tertiary vitreoretinal referral service for East London. Ethical approval was waived for data collection from the Clinical Effectiveness Unit at Barts Health NHS Trust (study ID 14078).

Intervention

All cases of successful retinal detachment repair requiring SO tamponade (viscosity 1,000–2,000cSt, Sigma-Aldrich, USA) with subsequent removal (ROSO), irrespective of RD aetiology and the timing of ROSO, were included in this study between the period of 12th July 2018 till 12th July 2022. Successful repair was defined as anatomical retinal re-attachment after a single procedure, or successive procedures, with no residual fluid that could spread; subretinal fluid anterior to laser demarcation lines was allowed. Cases included patients aged 18 years or older, RDs that required multiple procedures, and at least one-year postoperative follow-up.

Data collection

Data was collected at 1-month, 3-months, 6-months and 12-months. Best Recorded Visual acuity (BRVA, pinhole or spectacle correction) was measured using a logMAR chart (two decimal places). BRVA reported as counting fingers (CF), hand movements (HM), perception of light (PL) and non-perception of light (NPL) were converted to respective logMAR values of 1.90, 2.30, 2.70 and 3.00 [28, 29]. Intraocular pressure (IOP, mmHg) was measured using portable rebound tonometry (iCare, Vantaa, Finland). Moderate and severe visual loss were defined as loss of 3–5 lines the ETDRS chart (increase by 0.3–0.5 units of LogMAR) and loss of ≥ 6 lines on the ETDRS chart (increase ≥ 0.6 units of LogMAR) respectively [22].

Postoperative complications were recorded as per the CORDS Severity Classification [22]. CORDS was designed using a Delphi process with consensus from 45 international retinal surgeons. The classification system examines a total of 84 postoperative complications in retinal surgery: general (37 items), pars plana vitrectomy (25 items), scleral buckle (14 items) and pneumatic retinopexy (8 items). Scores range between one (smallest severity score) to 10 (greatest severity score). Our analysis was restricted to postoperative complications only from the general and PPV categories. Complications were scored only once unless a complication persisted in follow-up, reoccurred or was chronic, then this was scored repeatedly.

VA loss attributable to surgery (moderate or severe), an item within CORDS, was treated as an all-encompassing category and included complications that may have been counted elsewhere in the CORDS Severity Classification. Duplicates within this item were removed for the purposes of descriptive statistics, the Modified Global Complication Score (MGCS) and statistical testing between groups.

Modified Global Complication Score

There are supplementary tables provided by the CORDS Study Group that allow for the reporting of complications according to categories (mild, moderate and severe), or as simple frequencies with respective severities [22]. As part of our study, a Modified Global Complication Score (MGCS) was calculated to provide a single global value that can be used for future retinal studies using the CORDS Severity Classification.

The MGCS is calculated as a percentage of the 'Total Complication Score' divided by the 'Maximal Complication Score' (**Figure 1**). The total complication score (numerator) is the sum of all study-specific complication frequencies once multiplied by their respective CORDS severity scores. The maximal complication score (denominator) is the sum of all study-specific CORDS severity scores once multiplied by the study-specific sample size. Only complications that have been identified during study data collection can contribute to the MGCS calculation.

Analysis

Data was analysed using descriptive statistics and parametric tests. Categorical variables are presented in counts (n) and percentages (%). Continuous variables are presented as mean (μ) and standard deviation (SD). The distribution of continuous variables was assessed and differences between groups was compared using one-way ANOVA and Tukey's multiple comparisons tests. Comparisons with a one-sided P-value less than 0.05 were considered statistically significant.

RESULTS

Participants

In total, 67 eyes underwent ROSO between 12th July 2018 and 12th July 2022. A total of 21 eyes were excluded: incomplete one-year follow-up (12), retained SO (7), and data repeats (2). The final ROSO cohort for the specific period was 46 eyes from 45 patients (**Table 1**).

Best recorded visual acuity & intraocular pressure outcome

BRVA was recorded prior to RD repair with SO tamponade (before SO), following SO tamponade (before ROSO) and up to one-year following ROSO at 1-month, 3-month, 6-month, and 12-month intervals. The mean (SD) BRVA was 1.53 (0.84) prior to primary repair, 1.42 (0.64) before ROSO, and at specific postoperative intervals: 1.33 (0.79) at 1-month, 1.28 (0.81) at 3-months, 1.33 (0.86) at 6-months, and 1.37 (0.94) at 12-months. There was no statistically significant difference between BRVA across follow-up timepoints ($F[5,156]=0.11$, $P=0.99$), despite overall clinical improvement in BRVA from baseline to 12-month follow-up.

Intraocular pressure (IOP) was recorded on the same timescale as BRVA. The mean (SD) IOP (mmHg) was 14.4 (3.52) prior to primary repair, 20.9 (9.21) before ROSO, and at specific postoperative intervals:

18.3 (10.3) at 1-month, 17.4 (9.96) at 3-months, 18.3 (9.59) at 6-months, and 14.5 (6.86) at 12-months. There was a statistically significant difference in IOP amongst the follow-up timepoints ($F[5,216]=3.03$, $P=0.01$). The difference in IOP 'before SO' versus 'before ROSO' ($M_1=14.4\text{mmHg}$, $M_2=20.9\text{mmHg}$, mean difference -6.50 , 95%CI -12.25 to -0.650 , $P=0.02$), and 'before ROSO' versus '12-months' ($M_1=20.9\text{mmHg}$, $M_2=14.5\text{mmHg}$, mean difference $+6.40$, 95%CI $+0.581$ to $+12.3$, $P=0.02$) was statistically significant.

Complication frequency & severity outcomes

All complications were defined as per the CORDS Severity Classification [22]. There were in total 122 recorded postoperative complication items collectively across the general (94) and PPV-specific (28) categories of the CORDS Severity Classification. This sum allowed for duplicate items to be captured by the 'loss of VA attributable to surgical procedure' item (46 items total), which included a subset of complications not recognised by CORDS but contributing to VA loss (12 items). Removing duplicate items for frequency data, the total complication item count was 88: general (60) and PPV-specific (28).

Postoperative complications are presented as frequencies (counts) at the 1-month, 3-month, 6-month, and 12-month intervals. Complications are divided into general (**Figure 2**) and pars plana vitrectomy (PPV)-specific (**Figure 3**). Multiplying complication frequencies by respective severity scores [22], the mean (SD) severity scores were 8.88 (7.86) at 1-month, 14.0 (10.2) at 3-months, 6.29 (4.68) at 6-months and 7.54 (4.25) at 12-months. There was a statistically significant difference in mean severity scores across follow-up timepoints ($F[3,44]=3.06$, $P=0.04$). The difference in mean severity score at '3-months' versus '6-months' ($M_1=14.0$, $M_2=6.29$, mean difference $+7.71$, 95%CI 0.470 to 15.0 , $P=0.03$) was statistically significant.

Loss of BRVA attributable to surgical procedure, both moderate and severe, were treated as an all-encompassing item with duplicates allowed from other recorded items in the CORDS Severity Classification (total complication count 122). Loss of BRVA attributable to surgical procedure (moderate) involved 12 patients and included 23 complication items to account for the BRVA loss: 1-month (10), 3-months (1), 6-months (6) and 12-months (6). Allowing for duplicate items, moderate loss in BRVA equated to 18.9% (23/122). At 1-month, this included vitreous haemorrhage (1), high IOP that required drop therapy (2), inferior subretinal fluid (SRF) (1), PCO (1), hypotony that was self-resolving (2), macular oedema (1), anterior displacement of SO (1) and an unknown case (1). At 3-months, this included macular oedema (1). At 6-months, this included corneal decompensation (1), iris rubeosis with raised IOP that required drop therapy (1), inferior SRF (1), NVG with persistently raised IOP requiring surgery (1), macular oedema (1) and retinal redetachment due to PVR (1). At 12-months, this included corneal decompensation (1), non-infectious uveitis (1), inferior SRF (1), phthisis (1), macular oedema (1) and an unknown case (1).

Loss of BRVA attributable to surgical procedure (severe) involved 8 patients and included 23 complication items to account for the BRVA loss: 1-month (4), 3-months (8), 6-months (5) and 12-

months (6). Allowing for duplicate items, severe loss in BRVA equated to 18.9% (23/122). At 1-month, this included retinal redetachment due to a new tear (1), hyphaema (1) and anatomical displacement of the fovea (1) and an unknown case (1). At 3-months, this included early self-resolving hypotony (1), anterior displacement of SO (1), hyphaema (1), high IOP that required drop therapy (1), repeat vitreous haemorrhage (1), NVG with persistently raised IOP that required drop therapy (1), NVG with persistently raised IOP that required surgery (1) and anatomical displacement of the fovea (1). At 6-months, this included persistent hypotony without macular folds (1), non-infectious uveitis (1), high IOP that required drop therapy (1), NVG with persistently raised IOP that required drop therapy (1), NVG with persistently raised IOP that required surgery (1), and anatomical displacement of the fovea (1). At 12-months, this included non-infectious uveitis (1), phthisis (1), NVG with persistently raised IOP that required drop therapy (1), corneal decompensation (1), NVG with persistently raised IOP that required drop therapy (1), and anatomical displacement of the fovea (1).

In terms of lens status, there were 37 pseudophakic and nine phakic patients in the postoperative follow-up after ROSO. 27.0% (10/37) developed posterior capsular opacification (PCO) in the pseudophakic subgroup and 44.4% (4/9) developed cataracts in the phakic subgroup. Only 2.70% (1/37) pseudophakic cases had moderate loss of BRVA due to PCO.

Modified Global Complication Score

The total complication score was 438 and the maximal complication score was 4600, resulting in a MGCS of 9.52% for our ROSO cohort (**Table 2**).

DISCUSSION

Postoperative complication reporting in vitreoretinal surgery lacks standardisation [21, 22]. This is crucial in RD cases involving SO tamponade due to the risks of unexplained vision loss following ROSO [16–18] and the toxicity of long-term SO tamponade [3–10]. Standardised grading improves transparency in surgical outcomes, enables comparison across studies and tailors the preoperative counselling, or postoperative follow-up interventions, for ROSO cases [22, 24, 26]. In our study, the mean BRVA improved and mean IOP remained stable. The MGCS of 9.52% provides a global complication measure whilst setting a benchmark for future retinal studies. High-severity complications related to SO toxicity, such as corneal decompensation, secondary glaucoma and phthisis, developed after six months.

Classification systems for postoperative complications

Standardised reporting of postoperative complications has long been established in other surgical fields [24–26]. In ophthalmology, the standardisation of postoperative complications has been a recent

development with landmark consensus-driven studies in the field of glaucoma [23] and vitreoretinal surgery [22]. Both studies [22, 23] pave the way for comprehensive complication scoring tools in ophthalmology, whilst highlighting the ongoing debate about the best method of reporting complication data and the different thresholds for defining a complication amongst surgical experts. Complication data is especially important in clinical trials where it is an important outcome for intervention comparison, yet many trials remain underpowered to detect significant changes in complication outcomes [30].

Debate also exists with the reporting of complication data. Traditional metrics, such as frequency tables, prove insufficient as not all complications are equal in severity and statistical analysis proves difficult with multiplicity of testing and underpowered sample sizes [30–32]. In our study, we propose the use of a single global metric – the MGCS – that builds on pre-existing work from the CORDS Study Group [22]. A single summary value is a useful starting point for comparison between studies that employ the same complication scoring tool. To increase the uptake of standardised complication reporting [22, 23], research questions need to be framed and powered adequately to detect signals in complication data, whilst EPRs need to be robust in supporting accurate data collection [30].

ROSO-related complications

In terms of complications witnessed following SO tamponade and ROSO, the specific complications reported include cataract formation, corneal decompensation, persistently raised IOP, hypotony, SO emulsification, and recurrent RD [3–10, 16–18]. Investigators report in their ROSO cohort of 85 patients a retinal re-detachment rate of 25%, persistent hypotony in 16% and expulsive suprachoroidal haemorrhage in 1% of cases. These figures are higher than our study figures but are likely explained by the earlier removal of SO tamponade (between 9.1–20.2 weeks) and the more extremis patient cohort (GRT and advanced PVR) [5]. The Silicone Study of 1985–1990 [33] achieved ROSO in 99 eyes (8 weeks minimum of SO tamponade) and reported the following postoperative complication frequencies: retinal re-detachment (18%), loss of VA (20%), raised IOP (1%), hypotony (16%) and keratopathy (20%) [8]. A more recent study [17] reported on 101 eyes that underwent RD repair, irrespective of aetiology, with a mean ROSO time of 9.46 months. The latter group reported corneal decompensation in 10.9%, CMO in 2%, persistent hypotony in 7.9%, ocular hypertension in 12.9%, retinal re-detachment in 6.9% and anterior SO migration in 4.9% of cases. Our complication results share similarities with previous ROSO studies [5, 8, 17], but report higher rates of anterior SO migration (12.5%), CMO (12.5%) and ocular hypertension that required treatment (14.8%). Rates of retinal re-detachment (5.68%), corneal decompensation (5.68%) and persistent hypotony with phthisis (4.55%) are lower than previous studies [5, 8, 10, 17].

Deterioration of vision following ROSO can be divided into explainable and unexplainable causes [16, 18, 20]. Explainable VA loss (≥ 2 Snellen lines of BRVA) ranges between 13.0–36.1% in previous studies [6, 10, 18, 20, 34]. The highest reported VA loss following ROSO is 36.1% in comorbid eyes that had undergone prior retinectomy with SO tamponade and ROSO at 12 months [34]. Our study highlights 46 (37.7%) complication items contributing to moderate and severe vision loss following ROSO in comorbid

eyes, which includes both explainable causes using the CORDS Severity Classification and three cases (6.52%) with unexplainable causes. The overall reported incidence of unexplained vision loss following ROSO is estimated to be between 3.3–10.9% but can be as high as 50% in cases of RDs secondary to giant retinal tears [16].

Rationale for findings

The rationale behind our study's higher rates of postoperative complications, specifically anterior SO migration, raised IOP and vision loss, is likely related to the longer period of initial SO tamponade (mean 8.2 months). Current literature highlights the average timing for ROSO ranges between 3–6 months [5–10], with a recent meta-analysis [4] reporting a mean duration of 4.35 ± 3 months being sufficient for anatomical restoration. In instances of prolonged SO tamponade, there is not only an increased risk of SO emulsification and migration, resulting in microvascular obstruction and neural tissue infiltration, but also ionic and cytokine dysregulation, which precipitates cellular damage [3, 11–13, 20]. Longer durations of SO tamponade have been observed to have worse visual outcomes [18]. The impact of viscosity and brand of SO has also been examined on emulsification rates, but the literature remains inconclusive [2–4].

The intraocular environment influences SO migration with inflammatory states and surfactant products promoting SO emulsification [3]. Our cohort of tractional RDs with significant vascular risk factors, such as diabetes, reflects a stereotypical East London demographic [35]. Diabetes and other vascular occlusive disease enhance intraocular inflammation during or after SO tamponade, facilitating emulsification and migration of SO droplets [3, 12–15]. Furthermore, the presence of inflammatory mediators and cellular components in the vitreous cavity can act as surfactants, further facilitating SO emulsification [3]. This results in a vicious cycle of emulsified SO infiltrating nearby ocular tissue and further worsening the pro-inflammatory ocular state [11, 12]. The difficulty in achieving full ROSO also leads to persistent inflammation. Reported emulsification rates vary widely, from 9.45% in a recent meta-analysis [4] to 27.7% in specific studies with 45.1% anterior chamber migration [3]. The migration of emulsified SO droplets can block aqueous humour drainage networks [13], or trigger trabeculitis [11], providing a rationale for our higher rate of raised IOP cases.

Limitations

Our study holds several limitations. Firstly, it applies consensus criteria that is designed for prospective clinical trials and not retrospective reviews. Secondly, extracting data from EPR records can be challenging and result in measurement bias. Thirdly, the CORDS Severity Classification carries certain limitations, such as the issue of missing complications (e.g. hyphaema) that are encompassed in broader item headings (e.g. VA loss). Fourthly, due to the retrospective nature of our study, it was challenging to distinguish complications that were exacerbated by surgery, or those that followed the

natural sequelae of inherent ocular comorbidity (e.g. secondary glaucoma following either proliferative diabetic retinopathy, or SO toxicity).

Conclusions

SO tamponade in the management of complicated RDs and ROSO carry inherent risk. Our retrospective study has made use of CORDS Severity Classification to identify and score complications of ROSO in a complex and comorbid RD cohort. A Modified Global Complication Score is suggested to provide a single unifying value has set the benchmark for comparison amongst future retinal studies. Future work needs to use the CORDS Severity Classification in prospective vitreoretinal studies and consider using the MGCS as an adjunct measure. Finally, an overdue review of ROSO-related complications would be helpful in the context of unexplained vision loss following ROSO.

STATEMENTS AND DECLARATIONS

Competing Interests

All authors have no financial, or non-financial, interests to disclose that relate to this project work and academic dissemination.

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Human Ethics and Consent to Participate

This retrospective study was formally registered with the Clinical Effectiveness Unit (CEU) at the Barts Health NHS Trust (London, UK) on 15th July 2024. Final approval was gained on 19th July 2024 to proceed with this study. Ethical approval was formally waived through consultation with the CEU and no formal consent for retrospective data collection was required from participants. The retrospective study received formal project identification (study ID 14078). Where applicable, this study adhered to the standards outlined in the 1964 Declaration of Helsinki, and its later amendments, as well as local Data Protection Policy (Barts Health NHS Trust, UK) and Good Clinical Practice (National Institute for Health and Care Research, UK).

Author Contribution

All authors (YSB, SR, CM, HJZ) made substantial contributions to the design of work, analysis, drafting of manuscript, critical analysis, approval for publication and accountability for academic integrity.

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Tables

Tables 1 and 2 are available in the supplementary files section

Figures

$$MGCS = \frac{(f_a * CORDS_a) + (f_b * CORDS_b) + (f_c * CORDS_c) + \dots (f_z * CORDS_z)}{n * (CORDS_a + CORDS_b + CORDS_c + \dots CORDS_z)}$$

Figure 1

Modified Global Complication Score (MGCS) is calculated as total complication score divided by maximal complication score. Total complication score (numerator) is the sum of all individual study-reported complications (as weighted by CORDS), which have been multiplied by their respective study-reported frequency (f). Maximal complication score (denominator) is the sum of all study-reported complications (as weighted by CORDS), followed by multiplication by the study sample size (n).

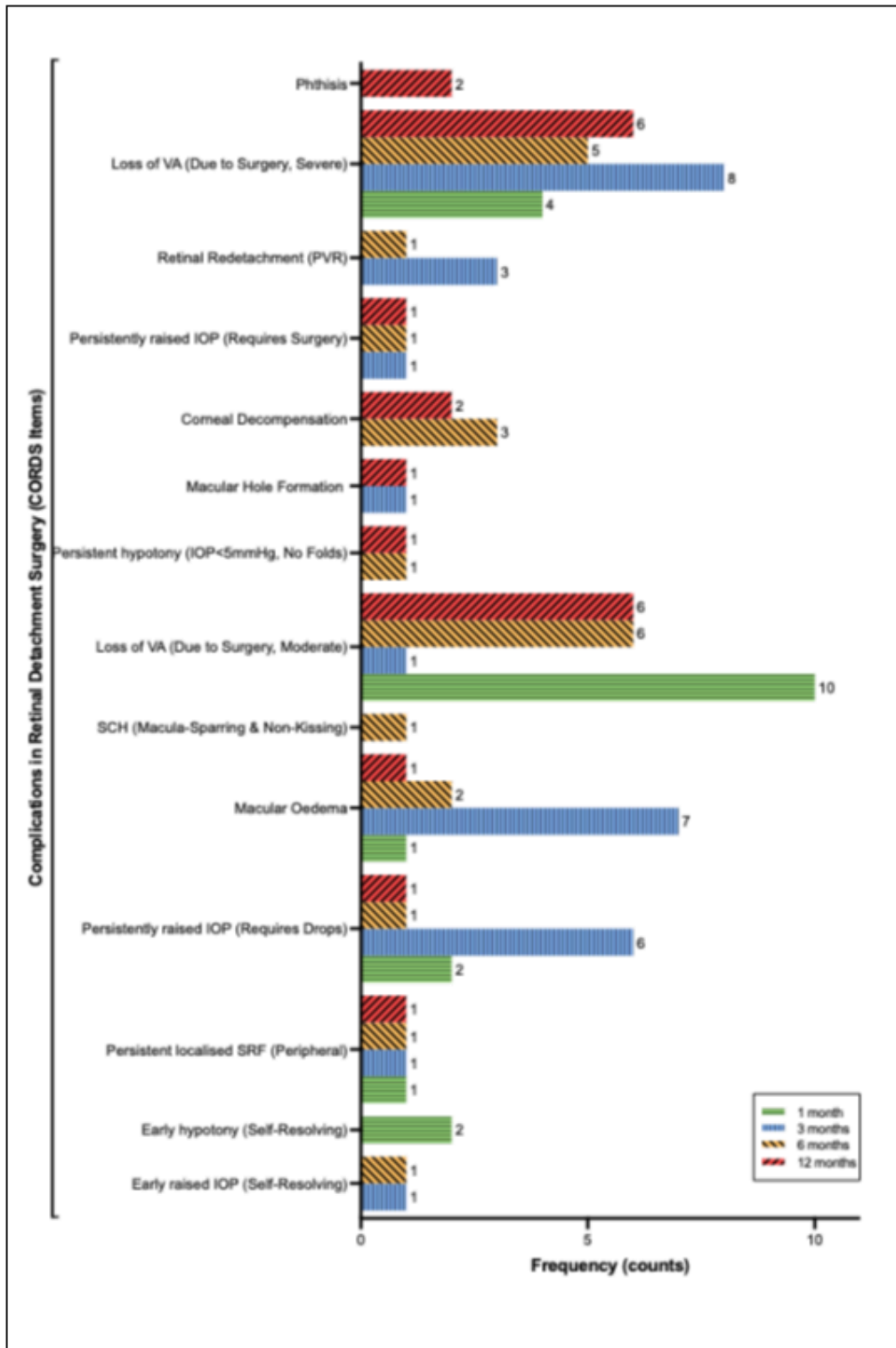


Figure 2

94 items recorded in the general postoperative complications of our removal of silicone oil cohort using the Complications of Retinal Detachment Surgery (CORDS) Severity Classification.[22] A total of 48 events were recorded for general postoperative complications combined with 46 duplicated items encompassed within the 'loss of visual acuity attributable to surgical procedure'. Frequency of complications are provided over a one-year follow-up period at 1-month, 3-month, 6-month, and 12-

month intervals. Frequency data is presented with a total complication count of 88: general (60) and PPV-specific (28).

Abbreviations: IOP; intraocular pressure, SRF; subretinal fluid, SCH; suprachoroidal haemorrhage, VA; visual acuity, mmHg; millimetres of mercury.

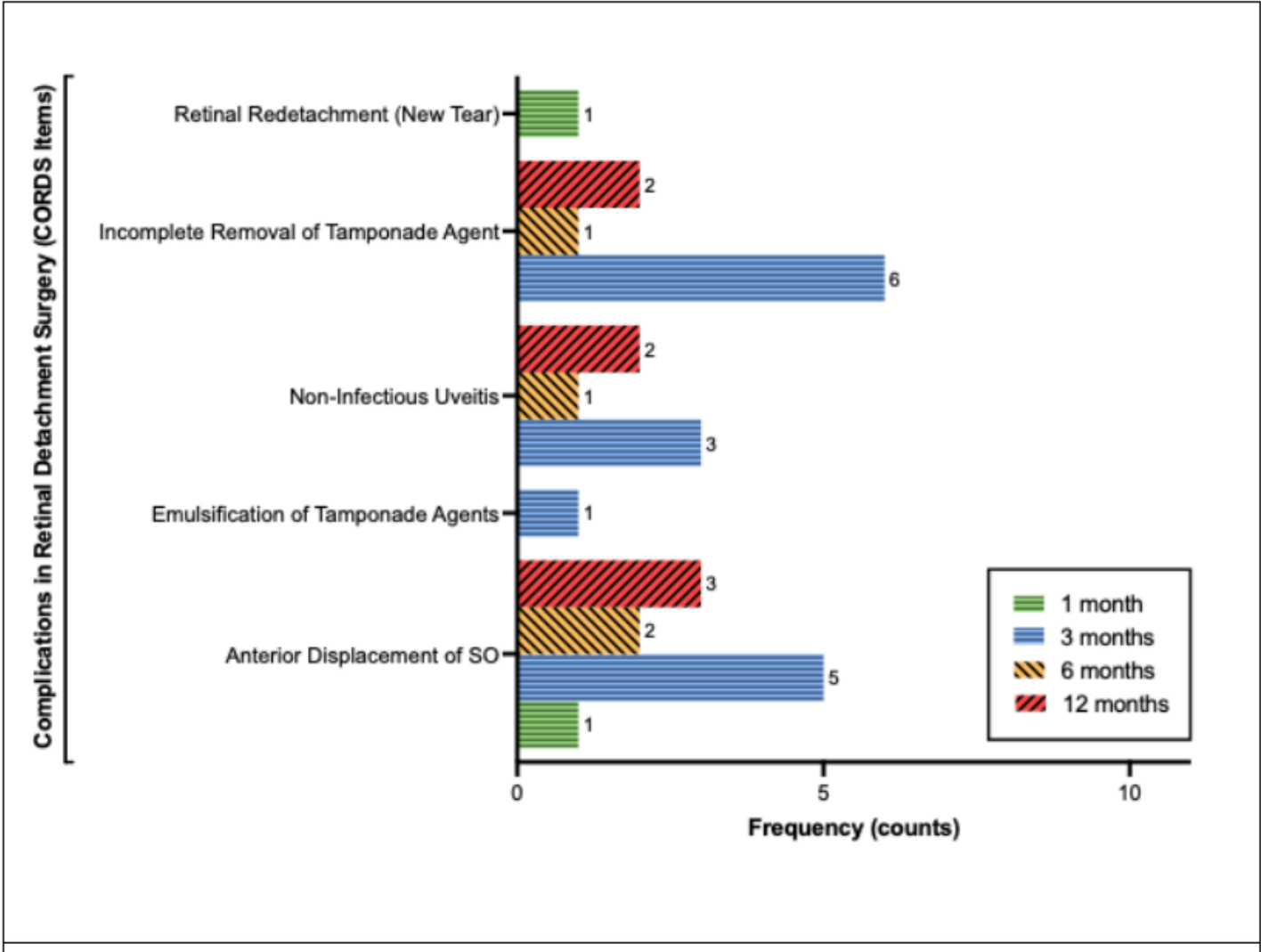


Figure 3

28 items recorded in the pars plana vitrectomy (PPV)-specific postoperative complications of our removal of silicone oil cohort using the Complications of Retinal Detachment Surgery (CORDS) Severity Classification.[22] A total of 28 events were recorded with no duplicates. Frequency of complications are provided over a one-year follow-up period at 1-month, 3-month, 6-month, and 12-month intervals. Frequency data is presented with a total complication count of 88: general (60) and PPV-specific (28).

Abbreviations: SO; silicone oil.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TablesOnly.docx](#)