Refractive outcome of cataract surgery in eyes filled with silicone oil

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Abstract

Background Cataract development is common in phakic eyes filled with silicone oil (SO), necessitating subsequent cataract removal. This study evaluated the refractive outcome in eyes filled with SO undergoing phacoemulsification cataract surgery (PCS).

Methods This retrospective study evaluated patients with SO tamponade who were scheduled for PCS.

Results Subjects ($n=26$) were followed-up for 29.5 ± 13.9 months after cataract surgery. The median spherical equivalent refraction (SER) was +5.3 D (interquartile range [IQR] +2.9 to +6.7) before PCS, and +3.4 D (IQR +2.0 to +4.4) after PCS. Within the follow-up period retinal reattachment after SO removal was achieved in 15 out of 26 eyes (57.7%). In 13 eyes assessment of refraction after SO-removal was possible, and showed a myopic shift of -4.6 D (IQR -2.9 to -7.3) in the SER. After SO removal, 5 of 13 eyes (38.5%) were within ± 1.0 D of the target refraction, while 9 out of 13 eyes (69.2%) were within ± 2.0 D.

Conclusions The refractive outcome after PCS for eyes filled with SO is less predictable than that for normal eyes. Some of the eyes undergoing silicone oil injection may require long-term tamponade.

Background

Silicone oil (SO) is used mainly when managing complex retinal detachments, commonly with proliferative vitreoretinopathy, and as a hemostatic agent in proliferative diabetic retinopathy [1]. Many surgeons prefer phacoemulsification cataract surgery (PCS) and pars plana vitrectomy even for cataracts that are not clinically significant. However, combined surgery has disadvantages, including that it is more difficult to perform, has a longer operating time, and involves a possible loss of corneal transparency [2]. Moreover, PCS can lead to zonular weakening with consecutive silicone oil displacement into the anterior chamber. An advantage of sequential surgery is that it induces less postoperative anterior chamber inflammation, and thus may be recommended in proliferative diabetic retinopathy or retinal detachment [2,3]. A recent study in France found that combined surgeries accounted for only 15.8% of vitreoretinal procedures performed in 2005–2014 [4].

Cataract development is common in phakic eyes filled with SO, necessitating subsequent cataract removal. PCS is commonly performed with concomitant SO removal [5–7]; however, in most cases, PCS can be performed while leaving the SO in place [8]. This study evaluated the refractive outcome of biometry in eyes filled with SO undergoing PCS.

Methods

This retrospective study included patients with 1000 cS or 5000 cS SO tamponade who were scheduled for cataract surgery at the Department of Ophthalmology, Medical University of Gdańsk, Poland between January 2012 and December 2017. Only individuals with nuclear and/or cortical cataract who underwent PCS with in-the-bag intraocular lens (IOL) placement, with follow-up data for a minimum of 3 months

after PCS and who had three reliable objective refractive error measurements at any time-point were included in the study. Subjects with inconceivable objective refraction, with a cataract due to capsular touch during vitrectomy, or with macular detachment in the ophthalmic examination and/or optical coherence tomography during assessment of refraction were excluded.

Preoperatively, all patients underwent a standard ophthalmological examination. Experienced examiners performed the biometry in an upright position using Alcon Ocuscan RxP (Alcon®, Fort Worth, Texas, USA) according to the departmental standards. The IOL power was calculated based on axial length (AL) using the SRK/T, Hoffer, or Holladay formula, as recommended by Hoffer [9]. The ultrasound velocity for the vitreous compartment was set as 986 m/s [10]. The target refraction was -0.5 D. Surgeries were conducted under topical anaesthesia and all patients received an acrylic one-piece IOL with a hydrophobic surface, the Acriva UDB 625 (VSY Biotechnologies, Amsterdam, Netherlands). The refractive error was assessed objectively using the Nidek ARK-530A (Nidek Co., Ltd., Aichi, Japan). Each measurement was evaluated as reliable if three subsequent measurements were obtained, and if the patient maintained fixation during the examination.

The Shapiro-Wilk test was applied to assess the distribution of the analyzed data. Variables following a Gaussian distribution are described using means and standard deviations, otherwise the median and interquartile range (IQR) are stated. The differences in the results at consequent timepoints in normally distributed data were calculated using the paired t test, otherwise the Skillings-Mack test was applied. Results with $p < 0.05$ were considered statistically significant. Visual acuity is presented in US equivalent form (Snellen). Counting fingers at 60 cm was assigned to a visual acuity of 20/2000, while hand movement was converted to 20/20000 [11].

Results

Thirty-two eyes of 32 patients underwent cataract surgery within the observation period. Six patients were excluded from the analysis because they were lost to follow-up due to unavailable medical records (2 patients), inconceivable autorefractometry (3 patients), or death (1 patient). Finally, outcomes were analyzed for 26 eyes of 26 patients. In all cases, the preceding vitrectomy was performed at the same clinic, and the mean interval between vitrectomy with SO tamponade and PCS was 9.1 ± 8.1 months. The median spherical equivalent refraction (SER) before PCS was $+5.3$ (IQR $+2.9$ to $+6.7$), and the cylinder was -1.87 D (IQR -2.81 to -0.75). Table 1 summarizes patients' data.

The median SER after cataract surgery ($n = 26$) was $+3.4$ D (IQR $+2.0$ to $+4.4$), and the median refractive cylinder was -1.8 D (IQR -2.8 to -0.8). Figure 1 presents the detailed refractive outcomes at all timepoints. After PCS, the best corrected visual acuity was 20/500 (IQR 20/2000 to 20/200), and the intraocular pressure was 17.6 ± 3.6 mmHg; neither differed statistically from the preoperative results ($p = 0.10$ and $p = 0.79$, respectively).

Subjects were followed-up for 29.5 ± 13.9 months after cataract surgery [Table 2]. Within this period, retinal reattachment was achieved after SO removal in 15 of 26 eyes (57.7%). Of these, 12 eyes (46.1%) required only one procedure. In two eyes, SO was reintroduced intraoperatively after the primary removal and additional vitrectomy and retinectomy; in 1 eye SO was reintroduced twice. Subsequently, these patients had the SO removed within 3 months with an intraocular 30% sulfur hexafluoride tamponade applied. The mean time between PCS and successful SO removal was 7.2 ± 5.4 months. In four eyes, SO was injected directly after removal, with no attempts to remove postoperatively. In seven eyes, no attempt was made to remove SO because of a poor prognosis.

In 13 eyes, refraction assessed after 1000 cS SO removal, which showed a myopic shift of -4.6 D (IQR -2.9 to -7.3) in the SER, differing statistically from the preoperative values ($p < 0.01$; Appendix 1). The SER after SO removal was -0.9 D (IQR -2.1 to 0.6), and the refractive cylinder was -1.5 D (IQR -2.3 to -1.0). The cylinder did not differ at any time-point ($p > 0.05$). After removing SO, 5 of 13 eyes (38.5%) were within ± 1.0 D of the target refraction, while 9 of 13 eyes (69.2%) were within ± 2.0 D. After successful SO removal one eye developed open-angle glaucoma and required implantation of an Ex-press glaucoma drainage device (Alcon®, Fort Worth, Texas, USA).

Discussion

Until 2016, the Polish National Health System reimbursed only sequential surgeries, and not phacovitrectomies. Thus, in our study all patients underwent sequential surgery as the method of choice. In 7 out of 26 eyes (26.9%) no attempts were made to remove SO. Thus, it should be questioned, whether in these cases the patients should have undergone PCS. Moreover, in 7 out of 19 eyes (36.8%) in which there was an attempt to remove SO after PCS, it had to be promptly reintroduced. Despite modern vitreoretinal techniques, SO removal is unfeasible in some cases, and the SO must remain in the eye indefinitely. The rates of the aforementioned cases is likely underreported [12]. In some studies, the retinal reattachment rate was reported to be as low as 30.0% [13,14]; in our cohort 42.3% of eyes required long-term SO tamponade.

Although patients with long-term SO tamponade generally present poor vision, an additional IOL power between $+3.0$ D to $+3.5$ D was previously recommended depending on the axial length of the eye [15,16]. Our study revealed that with the target of -0.5 D the refraction after PCS in siliconized eyes was $+3.4$ D (IQR $+2.0$ to $+4.4$), and a myopic shift of -4.6 D (with a high IQR of -2.9 to -7.3) manifested after silicone oil removal. The main limitations of the current study is that it employed contact A-mode scans for biometry, and had a limited group size. Optical biometry is generally more accurate than the applanation ultrasound technique [17]. However, some eyes cannot be measured using optical methods (e.g., dense cataracts); therefore, immersion A-scan biometry has an important role in these cases. Importantly, even if partial coherence interferometry is employed, the refractive outcome in eyes filled with silicone oil remains worse than that in normal eyes. For example, Al Habboubi et al. found that only 33.7% of eyes achieved the planned postoperative refraction of -2.0 D to $+0.25$ D [18]. Conversely, in normal eyes, 79.1% of cases should reach ≤ 0.5 D of the refractive target, while 97.2% should be within

≤ 1.0 D [19]. In eyes filled with silicone oil, axial length measurements can be significantly biased by limited vitreous base removal during the vitrectomy, partial filling of the vitreous chamber with SO resulting in retrosilicone space [5], macular edema or detachment, or incorrect parameters for AL adjustment [20]. Thus, one could consider performing biometry before vitrectomy when possible [21]. This may be limited by a macula-off retinal detachment, prior scleral buckling or surgery performed at another center. Biometry of the contralateral eye is another alternative, although this is impossible in monocular patients and inaccurate in patients with anisometropia, after scleral buckling or vitrectomy with SO tamponade.

Conclusions

SER after cataract surgery in eyes filled with SO is less predictable than in normal eyes. Similarly, the myopic shift after SO removal manifested a large IQR. A significant percentage of eyes undergoing silicone oil injection might require long-term tamponade.

List Of Abbreviations

IOL - intraocular lens

IQR - interquartile range

PCS - phacoemulsification cataract surgery

SER - spherical equivalent refractive error

SO - silicone oil

Declarations

Ethics approval and consent to participate: retrospective study - there is no need for approval from the local bioethical committee. A certificate is attached as supplementary material.

Competing interests: Dr. Kanclerz reports non-financial support from Optopol Technology and Visim. Dr. Grzybowski reports grants, personal fees and non-financial support from Bayer; grants, non-financial support from Novartis; non-financial support from Alcon, personal fees and non-financial support from Valeant, grants and non-financial support from Allergan, grants and non-financial support from Pfizer, grants, and financial support from Santen. Dr. Leisser and Dr. Lipowski has nothing to disclose. None of the authors has a proprietary/competing interest within the presented topic.

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Tables

Table 1. Patient data.

Mean age	54.9 ± 17.1 years
Sex	
- male	13
- female	13
Indication for primary vitrectomy with silicone oil tamponade	
- retinal detachment with proliferative vitreoretinopathy	18
- proliferative diabetic retinopathy with tractional retinal detachment	2
- proliferative diabetic retinopathy with vitreous hemorrhage	2
- vitreous hemorrhage and retinal detachment	1
- endophthalmitis with retinitis	1
- injury with intraocular foreign body	2
Viscosity of administered silicone oil	
- 1000 cS	25
- 5000 cS	1
Best corrected visual acuity	20/1000 (IQR 20/20000 to 20/400)
Intraocular pressure	15.9 ± 8.9 mmHg

Abbreviations: IQR - interquartile range

Table 2. Long-term follow-up in patients with silicone oil that have undergone cataract surgery

Outcome	Number of eyes
Silicone oil successfully removed in one procedure	12 (46.2%)
Silicone oil successfully removed in two or more procedures	3 (11.5%)
Silicone reintroduced after removal with no further attempts to remove	4 (15.4%)
No attempt to remove silicone oil due to poor prognosis	7 (26.9%)

Figures

Figure 1

Patient data.

Supplementary Files

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

- [RxOutcomeAppendix1.doc](#)