Comparison of outcomes for traumatic retinal detachment surgery using 1000- or 5000-centistoke silicone oil

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Abstract

Purpose: To compare the efficacy and complications associated with higher viscosity (5000-centistoke) versus lower viscosity (1000-centistoke) silicone oil in traumatic retinal detachment surgery.

Material and methods: Patients who underwent 23-gauge pars plana vitrectomy using 1000- or 5000-centistoke silicone oil to treat retinal detachment associated with traumatic globe injury were retrospectively analysed. Anatomical and visual outcomes were compared.

Results: Forty-four eyes of 44 patients were included in the study, which included 22 eyes in each group. Patients were significantly younger in the 5000-centistoke group compared to the 1000-centistoke group (median: 22 vs. 54 years old, respectively, p < 0.001) and open trauma was more common (77% vs. 36%, respectively, p = 0.006). Anatomical success was similar in both groups (73% and 77%, 5000- and 1000-centistoke groups, respectively; p = 0.73). Although ambulatory vision (>5/200) at the final follow-up visit was more common in the 1000-centistoke group compared to the 5000-centistoke group (55% vs. 9%, respectively, p < 0.001), there was no significant difference between the groups with respect to change in visual acuity postoperatively compared with preoperatively.

Conclusion: Surgeons prefer 5000-centistoke silicone oil for use in more complicated cases. Anatomical outcomes were similar using 1000- and 5000-centistoke silicone oil.

Keywords: Trauma, Retinal detachment, Silicone oil

Introduction

Ocular trauma is among the most frequent causes of blindness and ocular morbidity.1 Traumatic retinal detachment has unique characteristics and it constitutes an important subgroup of retinal detachment cases. Retinal detachment may occur after open- or closed-globe trauma, and it is among the strongest negative prognostic factors in the Ocular Trauma Score (OTS), which predicts final visual acuity after ocular trauma.2 However, it is difficult to predict visual outcomes after traumatic retinal detachment because of the diversity of types of ocular trauma and associated pathologies.

The use of silicone oil was first reported by Cibis et al.3 in 1962. Today, silicone oils are very important tools in vitreoretinal surgery and they are frequently used in the management of complicated retinal detachments. The viscosity of silicone oil is expressed in centistokes, which are related to the oil’s molecular weight. Most common types of silicone oils used in vitreoretinal surgery, have a viscosity of 1000 or...
5000 centistokes. Outcomes and complications after the use of 1000-centistoke silicone oil during retinal detachment repair are well-described. However, based on a literature search of the MEDLINE database, only two studies have compared patient outcomes after the use of 1000- vs. 5000-centistoke silicone oil. Furthermore, these studies included only a few traumatic globe injuries.

In this study, we describe clinical features and compared visual and anatomical outcomes, as well as complications of 23-gauge pars plana vitrectomy (PPV) using 1000- versus 5000-centistoke silicone oil in patients with traumatic retinal detachment.

Material and methods

This study followed the tenets of the Declaration of Helsinki, and approval was obtained from the institutional review board. Patients who had retinal detachment (RD) associated with traumatic globe injury and underwent PPV with 1000- or 5000-centistoke silicone oil in Beyoglu Eye Training and Education Hospital (BEH) during a two-year period (January 2014–January 2016) were retrospectively analyzed. Patients who underwent 12 months of follow-up were included in the study. Demographic data, types of injury, associated ocular conditions, preoperative and final visual acuities, and complications were recorded.

Visual acuities were classified into five groups according to the OTS study: No light perception (NLP), light perception (LP) or hand motion (HM), 1/200 to 19/200, 20/200 to <20/50, and 20/40 or better. Ambulatory vision was defined as the distance-corrected visual acuity of 5/200 or more. Types of injury were classified according to the Birmingham Eye Trauma Terminology System.

Anatomical success was defined as the total attachment of the retina at the final follow-up visit. Intraocular pressure (IOP) rise was defined as an IOP greater than 25 mmHg, and hypotony was defined as an IOP less than 5 mmHg. Corneal abnormality was defined as band keratopathy, corneal epithelial defects, or corneal scarring and edema.

Surgical technique

All eyes underwent standard 23-gauge PPV using the Constellation Surgical Vitrectomy System (Alcon Laboratories Inc., Fort Worth, TX, USA). Pars plana lensectomy (PPL) or phacoemulsification was performed, if indicated. Perfluorocarbon liquids were used to attach the retina, and retinal breaks were treated with endophotocoagulation. Relaxing retinotomies or retinectomies were performed when indicated, and a scleral buckle was placed when the anatomical status of the eye did not permit complete removal of the vitreous base. Silicone oil (1000 or 5000 centistokes) was used at the end of the surgery as an internal tamponade. Sclerotomies were sutured at the end of the surgery.

Statistical analysis

Statistical analysis was carried out using SPSS17.0 software (SPSS Inc., Chicago, IL, USA). Categorical variables were analyzed using the Chi-squared and Fisher’s exact test. Parametric and nonparametric variables were compared using the t-test and the Mann-Whitney U test between groups. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

Forty-four eyes of 44 patients were included in the study, and 22 patients were allocated into each group. The mean follow-up time was 14.1 ± 3.6 months. Patient characteristics, type of trauma, and time from trauma to PPV are presented in Table 1.

The patients were significantly younger and open trauma was significantly more common in 5000-centistoke group compared to the 1000-centistoke group. Preoperative ocular characteristics are presented in Table 2.

Associated ocular pathologies were not significantly different between the groups. Retinotomy or retinectomy was performed in four eyes (18%) in each group. Scleral buckle

Table 1. Patient characteristics, type of trauma and time from trauma to PPV.

|                         | 1000 cs SO | 5000 cs SO | Total | p      |
|-------------------------|------------|------------|-------|--------|
| Gender, No. (%)         |            |            |       | 0.99** |
| Male                    | 21 (95)    | 21 (95)    | 42 (95)|        |
| Female                  | 1 (5)      | 1 (5)      | 21 (5) |        |
| Age                     |            |            |       | <0.01**|
| Mean ± SD               | 48 ± 18    | 26 ± 16    | 38 ± 21|        |
| Median (Range)          | 54 (13–79)| 22 (4–68)  | 37 (4–79)|       |
| Trauma Type, No. (%)    |            |            |       | 0.006* |
| Open                    | 8 (36)     | 17 (77)    | 25 (63)|        |
| Closed                  | 14 (64)    | 5 (23)     | 19 (43)|        |
| Time from trauma to PPV |            |            |       | 0.330* |
| Mean ± SD               | 30 ± 27    | 22 ± 25    | 26 ± 26|        |
| Median (Range)          | 22 (9–100)| 14 (6–120)| 17 (6–120)|       |
| Follow-up               |            |            |       | 0.287**|
| Mean ± SD               | 13.3 ± 2.6 | 15.0 ± 4.3 | 14.1 ± 3.6|       |
| Median (Range)          | 12 (12–20)| 14 (12–24)| 12 (12–24)|       |

cs: centistoke, SO: silicone oil.
* Fisher’s exact test, two-tailed p value.
** Mann-Whitney U test, two-tailed p value.
* Chi-Squared test, two-tailed p value.
* T-Test, two-tailed p value.
was placed in two eyes (9%) in each group. PPL or phacoemulsification was performed in four eyes (18%) in each group during PPV. During follow-up, 4 (22%) and 5 (27%) of the remaining eyes in the 1000- and 5000-centistoke groups were operated on for visually significant cataracts (new cataract or progression of preexisting cataract), respectively (Chi-square test, p = 0.22). Mean duration of silicone oil tamponade was 6.1 ± 2.1 months in the 1000-centistoke group and 7.2 ± 1.8 months in the 5000-centistoke group (T test, p = 0.08). Five eyes (22.7%) in the 1000-centistoke group and 6 eyes (27.2%) in the 5000-centistoke group developed proliferative vitreoretinopathy and required an additional vitrectomy during follow-up (Chi-square test, p = 0.22). Mean duration of silicone oil tamponade was 6.1 ± 2.1 months in the 1000-centistoke group and 7.2 ± 1.8 months in the 5000-centistoke group (T test, p = 0.08). Five eyes (22.7%) in the 1000-centistoke group and 6 eyes (27.2%) in the 5000-centistoke group developed proliferative vitreoretinopathy and required an additional vitrectomy during follow-up (Chi-square test, p = 0.22).

Preoperative and postoperative distance-corrected visual acuities are presented in Fig. 1 and Fig. 2. Anatomical success was similar in both groups and there was no significant difference between the groups with respect to changes in visual acuity postoperatively compared to preoperatively. However, ambulatory vision (>5/200) at the final follow-up visit was more common in 1000-centistoke group (Table 3). Silicone oil emulsification was noted in 2 (9%) eyes in the 1000-centistoke group and 1 eye (4.5%) in the 5000-centistoke group (Fisher’s exact test, p > 0.99). There was no difference in postoperative complication rates (Table 4).

Discussion

In this study, we compared visual and anatomical outcomes for 23-gauge PPV between patients undergoing 1000- or 5000-centistoke silicone oil treatments for traumatic retinal detachment at a single tertiary eye hospital. Silicone emulsification is time-dependent, and it is a major problem because it leads to numerous complications. Although in vitro studies show that high-viscosity silicone oil has less of a tendency to emulsify, it is not clear if 1000- or 5000-centistoke silicone oils display a clinically significant difference in emulsification. Some authors have stated that less emulsification occurs in eyes treated with 5000-centistoke silicone oil, while others have found no difference between the two silicone oils. On one hand, higher-viscosity silicone oils may emulsify less. On the other hand, less viscous silicone oils can be introduced and removed more easily.

Based on a literature search of the MEDLINE database, there have been no published studies comparing surgeon preferences with respect to the use of 1000- vs. 5000-centistoke silicone oil as a retinal tamponade. However, we found that preoperative patient characteristics differ significantly between the 1000- and 5000-centistoke-treated groups. On average, patients were significantly younger, open-globe trauma was significantly more common, and visual acuity at the lower end (HM or LP) of the spectrum at presentation was significantly more common in the 5000-centistoke group compared to the 1000-centistoke group. Open-globe trauma (rupture or penetrating trauma), retinal detachment, and HM/LP visual acuity were among the worse prognostic factors in the Ocular Trauma Score. In our opinion, these findings show that surgeons prefer to use 5000-centistoke silicone oil on eyes when their postoperative expectations in terms of functional and anatomical success were lower. Other associated ocular pathologies, such as hyfema, cataracts, or vitreous hemorrhage, were not different among the groups. However, these complications are not strong predictors of subsequent visual acuity.

The anatomical success rate for patients in our study is comparable to that reported in the literature. Scott IU et al. compared visual and anatomical outcomes in 325 eyes after PPV using either 1000- or 5000-centistoke silicone oil. They found that outcomes, as well as emulsification and complication rates at 1 year, were similar in both treatment groups. They also reported that in traumatic cases, 1000-centistoke silicone oil was associated with a higher cumulative ret detachment rates. However, they had a total of 34 traumatic retinal detachments in only six of the eyes in the 1000-centistoke group. In our study, there were 22 patients in each group, and retinal redetachment rates were not significantly different between the groups.

### Table 2. Ocular characteristics.

|                          | 1000 cs SO | 5000 cs SO | p  |
|--------------------------|-----------|------------|----|
| No. (%)                  |           |            |    |
| Hyphema                  | 2 (9)     | 1 (5)      | >0.99*
| Cyclodialysis/Iridodialysis | 1 (5)     | 3 (14)    | 0.60*  
| Traumatic mydriasis      | 0         | 1 (5)      | >0.99*  
| Traumatic Cataract       | 10 (45)   | 14 (63)    | 0.29   
| Crystalline lens subluxation/dislocation | 2 (9) | 2 (9) | >0.99* |
| Intraocular hemorrhage   | 4 (18)    | 9 (41)     | 0.1    
| Choroidal detachment     | 2 (9)     | 4 (18)     | 0.66   
| Suprachoroidal hemorrhage| 1 (5)     | 2 (9)      | >0.99*  
| PVR Grade B             | 4 (18)    | 3 (14)     | >0.99*  

* Chi-squared test, two-tailed p value.  
# Fisher’s exact test, two-tailed p value.

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**Fig. 1.** Preoperative distance-corrected visual acuity.

**Fig. 2.** Postoperative distance-corrected visual acuity.
Comparison of 1000- vs 5000-cs silicone oil

Zafar et al. compared outcomes and complications after retinal detachment repair. Although complication rates were similar at 18 months, the 1000-centistoke group had a significantly higher frequency of oil emulsification that necessitated early removal. In contrast to Zafar et al. and in agreement with Scott et al., we found that emulsification rates and complications were similar in both groups. However, none of the eyes in the study conducted by Zafar et al. were traumatic. Thus, a direct comparison with the eyes in that study may be misleading. The emulsification rates in this series were not significantly different between the 1000- and 5000-centistoke groups. However, this may result from the relatively low number of patients in both groups. Also, a prospective study with gonioscopy performed at follow-up visits may show higher emulsification rates and may demonstrate a significant difference between the groups.

Ambulatory vision was more common in the 1000-centistoke group at the final visit. However, preoperative visual acuities were better in the 1000-centistoke group, and there was no significant difference between the groups with respect to change in visual acuity postoperatively versus preoperatively. In other words, better postoperative visual acuity was the result of better preoperative visual acuity and not a function of success resulting from 5000-centistoke silicone oil.

The major weakness of our study is its retrospective nature. Other studies in the literature are also retrospective but do not report enough data to show that they had no selection bias. In fact we believe that there will always be a selection bias in a retrospective study on traumatic eyes. Despite its inherent weakness, our study describes the functional and anatomical results in both groups in detail and underlies the need for a prospective blinded design with allocation concealment to reveal the advantages of each type of silicone oil in certain circumstances.

### Table 3. Anatomical and visual outcomes.

|                        | 1000 cs SO | 5000 cs SO | Total  | p     |
|------------------------|------------|------------|--------|-------|
| Retina totally attached| 17 (77)    | 16 (73)    | 33 (75)| 0.73  |
| Retina not totally attached| 5 (23) | 6 (27)    | 11 (25)|       |
| Ambulatory vision, N (%)|            |            |        |       |
| VA ≥ 5/200             | 20 (91)    | 12 (54)    | 30 (68)| 0.001*
| VA < 5/200             | 2 (9)      | 10 (45)    | 14 (22)|       |
| Change in visual acuity, N (%)|       |            |        |       |
| Stable/improved        | 21 (96)    | 18 (82)    | 39 (89)| 0.35  |
| Worse                  | 1 (5)      | 4 (18)     | 5 (11) |       |

### Table 4. Postoperative complications.

|                        | 1000 cs SO No. (%) | 5000 cs SO No. (%) | p     |
|------------------------|--------------------|--------------------|-------|
| Elevated IOP           | 1 (5)              | 3 (14)             | 0.61  |
| Hypotony               | 4 (18)             | 2 (9)              | 0.66  |
| Corneal abnormalities  | 3                  | 3                  | >0.99 |
| New cataract           | 13 (72)            | 13 (72)            | -0.99 |
| Hyphema                | 0                  | 2 (9)              | 0.48  |

IOP: Intraocular pressure, cs: centistoke, SO: silicone oil.

* Chi-square test, two-tailed p value.

** Fisher’s exact test, two-tailed p value.

Table 4: Percentages in each column may not equal 100% due to rounding.

** Fisher’s exact test, two-tailed p value.

### Conclusion

This study provides evidence that surgeons tend to use 5000-centistoke silicone oil in traumatic eyes that have worse presenting features. However, anatomical and functional results, as well as complication rates, were similar regardless of the silicone oil used.

### Conflict of interest

The authors declared that there is no conflict of interest.

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