• Clinical Research •

Trocar opening: silicone oil removal with phacoemulsification and intraocular lens implantation

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Abstract

• AIM: To evaluate the efficacy and safety of a modified technique [trocar opening (TO)] for silicone oil removal (SOR) in combination with phacoemulsification and intraocular lens (IOL) implantation.

• METHODS: A total of 60 eyes of 60 patients with cataract and silicone oil-filled eyes were enrolled in this study. The patients were divided into two groups: the patients in the control group underwent 23-gauge pars plana active SOR surgery with phacoemulsification and IOL implantation, while the patients in the TO group underwent TO methods during surgery. Best corrected visual acuity (BCVA), surgery time, intraocular pressure, and operative complications were observed 6mo after surgery.

• RESULTS: There was no significant difference between the two groups in terms of age, gender, preoperative, intraocular pressure, or time of silicone oil stay. Prior to surgery, the mean BCVA for the control and TO groups was 1.34±0.44 and 1.36±0.42. At 6mo following surgery, the mean BCVA improved to 0.74±0.36 and 0.77±0.32, respectively (*P*<0.001). There was no significant difference between the two groups. The mean SOR time was 6.9±2.3min and 4.8±1.2min in the control and TO groups (*P*=0.008). The total operation time was 28.2±8.5min and 24.6±6.4min, respectively (*P*=0.035). Posterior capsule rupture occurred in four eyes of control and none of TO group (*P*<0.01). Late recurrent retinal detachment occurred in one eye in the control group (2mo after surgery) and in one eye in the TO group (4mo after surgery).

• CONCLUSION: TO is a simple, effective, time-saving, and safe method for SOR combined with phacoemulsification and IOL implantation.

• KEYWORDS: intraocular lens implantation; phacoemulsification; posterior capsule rupture; silicone oil removal

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INTRODUCTION

Silicone oil filling in the vitreous cavity is a common method used to withstand the retina and maintain the intraocular pressure (IOP) in posterior eye surgery (proliferative vitreoretinopathy, proliferative diabetic retinopathy, giant retinal tears, and ocular trauma)[1]. However, there are several complications caused by silicone oil tamponade, such as silicone oil emulsification, secondary glaucoma, cataract, and corneal degeneration[2]. Therefore, it is suggested that the silicone oil should be removed as soon as its tamponade effect is no longer needed. In addition, it is recommended that a combined operation with cataract extraction and silicone oil removal (SOR) is necessary following the occurrence of secondary cataract[3].

Phacoemulsification in a vitrectomized eye is associated with a higher rate of posterior capsule rupture because of the hard nucleus[4]. Furthermore, the buoyancy of the silicone oil may lead to posterior capsule elevation and additional anterior chamber instability, which increase the risk of posterior capsule rupture[5]. The incidence of posterior capsule rupture during phacoemulsification in vitrectomized eyes or combined surgery has been reported between 1.5% and 10.1%, which is higher than that observed for normal phacoemulsification[4-6]. Therefore, in SOR combined with phacoemulsification, new approaches are warranted to reduce the incidence of posterior capsule rupture. Herein, we report a new method, termed trocar opening (TO), of SOR in combination with phacoemulsification and intraocular lens (IOL) implantation.

SUBJECTS AND METHODS

Ethical Approval The study protocol has been approved by the Institute's Ethics Committee on human research. This research adhered to the tenets set forth in the Declaration of Helsinki, and written informed consent was provided by all patients.

This consecutive case study was conducted from July 2017 to December 2017. A total of 60 patients (60 eyes) were included and underwent SOR in combination with phacoemulsification and IOL implantation. All previous 23-gauge (23G) transconjunctival sutureless vitrectomy surgeries were performed by a single surgeon in all patients. The indication for vitrectomy and silicone oil (Oxane® 5700; Bausch & Lomb, Rochester, NY, USA) injection were limited to patients with rhegmatogenous retinal detachment. The indication for SOR was attachment of the retina and the stability of silicone oil tamponade for ≥3mo. The indication for phacoemulsification and IOL implantation was visual acuity impaired by cataract.

All patients underwent measurements of keratometry, anterior chamber depth, and axial length using the IOL Master (IOL Master V1.1; Carl Zeiss Meditec, Jena, Germany). Ocular examination with best-corrected visual acuity (BCVA), applanation tonometry, slit-lamp biomicroscopy, and indirect fundus ophthalmoscopy was performed in all patients at baseline, 1d, 1wk, 1, 3, and 6mo after surgery. The main outcome measures were mean removal time, changes in BCVA and IOP, and intraoperative and postoperative complications. For statistical analysis, BCVA was converted to logarithm of the minimum angle of resolution (logMAR).

All patients, in which the density of the removed oil was 5700 cSt, were randomly divided into two groups: control and TO. In the control group (30 eyes), standard 23G active aspiration SOR with phacoemulsification and IOL implantation was performed. In the TO group (30 eyes), the TO method was used along with the procedures performed in the control group. All patients were under retrobulbar anesthesia with 2% lidocaine. The 23G trocar-cannulas (Alcon Lab., Inc., Fort Worth, TX, USA) were used to create two transconjunctival sclerotomies at the inferotemporal (intravitreous infusion) and superotemporal quadrants (SOR). The trocars were withdrawn with the microcannulas *in situ*, which were covered by microcannulas plugs in the control group and remained open in the TO group (TO method). Subsequently, a 3-mm width corneal incision was made, and anterior capsulorhexis was performed. Hydrodissection of the lens nucleus was performed, followed by phacoemulsification with irrigation and aspiration of the lens material using the Alcon CONSTELLATION® Vision System (Alcon Lab., Inc.). Subsequently, a soft foldable lens was injected in the capsular bag, and the cornea incision was sealed using 10/0 vicryl suture. The infusion tube was attached to the inferotemporal microcannulas, and the aspiration tube was attached to the superotemporal microcannulas to perform active SOR (with a negative pressure of 650 mm Hg and IOP at 25 mm Hg). Following the observation of a remaining oil bubble, the eyeball was tilted to place the oil bubble into the microcannula, which assisted in the complete removal of the silicone oil and prevention of sudden eyeball collapse. After complete SOR, a wide-angle viewing system was used to check the condition of the fundus. At the end of the surgery, all sclerotomy sites were sutured with 8/0 vicryl suture to prevent postoperative hypotony (Figure 1).

Table 1 Baseline demographic data and characteristics of the patients mean±SD

Parameters	Control group	TO group	*P*
Age (y)	52.2±9.2	54.7±8.4	0.687
Sex (male, %)	46.7	53.3	0.154
Right eye (%)	43.3	46.7	0.165
Pre-operative IOP (mm Hg)	16.7±3.4	17.5±3.7	0.435
Time of SO stay (mo)	5.4±2.4	5.8±1.8	0.562
BCVA (logMAR)	1.34±0.44	1.36±0.42	0.672

TO: Trocar opening; IOP: Intraocular pressure; SO: Silicone oil; BCVA: Best corrected visual acuity.

Statistical Analysis In this study, the SPSS software (version 13.0 for Windows; SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The data are presented as means±standard deviation (SD). The results were analyzed by analysis of variance. A $P<0.05$ denoted statistical significance.

RESULTS

A total of 60 patients (60 eyes) were included in our study. The baseline demographics and characteristics of the patients are summarized in Table 1. There was no significant difference between the two groups in terms of age, sex, pre-operative IOP, or time of silicone oil stay.

Surgery was successfully performed in all patients. The silicone oil was completely removed from all eyes. In the last follow-up after surgery, there was no significant residual oil in the anterior chamber or in the vitreous cavity. There were no serious intraoperative complications, except the occurrence of posterior capsule rupture in four eyes in the control group and IOLs were planted in the sulcus, and none in the TO group ($P<0.01$). Late recurrent retinal detachment occurred in one eye in the control group (2mo after surgery) and in one eye in the TO group (4mo after surgery). This was attributed to proliferative vitreoretinopathy and these patients were re-operated with pars plana vitrectomy and silicone oil tamponade. There was no recurrence of retinal detachment observed at the 6-month follow-up. In addition, there were no other postoperative complications (*e.g.*, vitreous hemorrhage, dislocated IOL, or endophthalmitis) observed.

The mean surgical time is summarized in Table 2. There was significant difference between the two groups. Cataract time was defined as the interval between making and sealing the cornel incision. SOR time was defined as the interval between the connection of the infusion tube and the sealing of the sclera incisions. Total time was defined as the interval between the patient on and off the operating table.

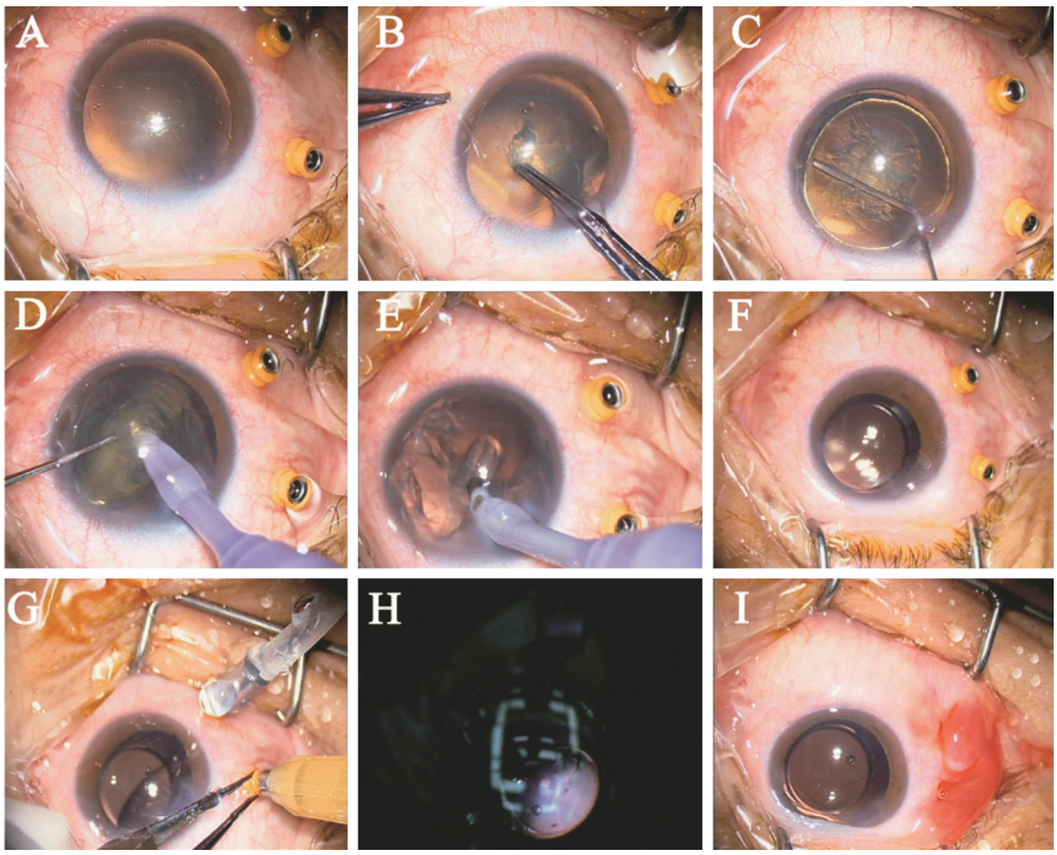

Figure 1 SOR with phacoemulsification and IOL implantation using the trocar opening method A: Unplugged microcannula placement in the inferotemporal and superotemporal quadrants 3.5 mm from the corneoscleral limbus; B: Continuous curvilinear capsulorhexis with silicone oil bubble was observed in the inferotemporal microcannula; C: Hydrodissection of the lens nucleus with silicone oil bubble in the same place; D: Phacoemulsification was performed with silicone oil bubble flow out in the inferotemporal and superotemporal microcannulas; E: Irrigation and aspiration of the lens material with silicone oil bubble in the same place; F: A soft foldable IOL was injected in the capsular bag; G: In 23G active aspiration SOR, the eyeball was tilted to place the oil bubble into the microcannula, following the observation of remaining oil bubble; H: A wide-angle viewing system was used to check the fundus; I: At the end of the surgery, all sclerotomy sites were sutured.

Table 2 Comparison of mean cataract time, SOR time, and operation time in the two groups mean±SD, min

Parameters	Control group	TO group	*P*
Cataract time	8.4±3.2	7.2±2.6	0.013
SOR time	6.9±2.3	4.8±1.2	0.008
Operation time	28.2±8.5	24.6±6.4	0.035

TO: Trocar opening; SOR: Silicone oil removal.

Table 3 Comparison of IOP in the two groups mean±SD, mm Hg

Post operation	Control group	TO group	*P*
1d	12.6±4.5	13.5±4.2	0.423
1wk	15.4±3.8	15.5±4.4	0.261
1mo	15.1±2.6	14.8±3.3	0.345
3mo	15.5±3.6	14.9±4.1	0.472
6mo	16.2±3.7	15.7±3.2	0.413

TO: Trocar opening.

The mean IOP is summarized in Table 3. There was no significant difference between the two groups, and hypotony did not occur. Except retinal redetachment, the remaining eyes showed improvement in BCVA at the last follow-up visit. Prior to surgery, the mean BCVA in the control and TO group was 1.34±0.44 and 1.36±0.42, respectively. At 6mo after surgery, the mean BCVA improved to 0.74±0.36 and 0.77±0.32, respectively (P<0.001). There was no significant difference between the two groups.

DISCUSSION

In this study, we reported a novel management strategy for SOR with phacoemulsification and IOL implantation. The results demonstrated that the TO method is simple, effective, time-saving, and safe. It involves only one step *i.e.*, maintaining the microcannulas unplugged during phacoemulsification and IOL implantation.

There are many methods used for SOR: transpupillary or pars plana, active or passive, 20G, 23G or 25G. Transpupillary is a simple and less invasive technique, associated with less trauma and better conservation of the blood-aqueous barrier function[3,7]. However, it is linked to the theoretical risk of damage to structures in the anterior chamber, and limits intravitreous performance when necessary[8]. The pars plana method is preferred, since it avoids irritation of the anterior segment and allows for sufficient examination of the retina[8].

For active suction, 23G aspiration tubes are available. However, the cannula needs to enter into the vitreous cavity through the microcannula of the trocar, thus narrowing the lumen of the tunnel. This type of technique could lessen surgical trauma and decrease patient discomfort; however, it is a time-consuming method for the removal of silicone oil of high viscosity[8-10]. Lin *et al*[11] used a temporal head position with fluid-air exchange for the passive drainage, which requires patients to turn their heads during surgery. Thus, this approach is unsuitable for patients under general anesthesia. A larger sclerotomy may accelerate removal, but induces more surgical trauma and postoperative discomfort. On the contrary, a smaller sclerotomy causes less surgical trauma but is less effective, particularly for the removal of silicone oil of high viscosity[8]. Therefore, according to these findings, 23G pars plana active SOR is a relatively effective method.

We introduced a new method of maintaining the TO during phacoemulsification and IOL plantation to overcome the buoyancy of the silicone oil. This approach offers two advantages. Firstly, one could let the silicone oil flow out of the opening trocar instead of directly elevating the posterior capsule, increasing anterior chamber stability and decreasing the possibility of posterior capsule rupture. In this study, posterior capsule rupture did not occur in the TO group, while it occurred in four of 30 eyes (13.3%) in the control group. This incidence was similar to those reported in other studies[4-6]. Secondly, this method could decrease the volume of the remaining silicone oil when initiating SOR, since the silicone oil is flowing out during the entire phacoemulsification. Thus, it can reduce the time needed for SOR. According to our results, the cataract time, SOR time, and operation time were shorter in the TO group versus the control group.

Yildirim *et al*[12] reported that the mean removal time through a corneal tunnel incision was approximately 7.6-9min for passive SOR. The mean time for passive removal of 1000 cSt silicone oil using 25G microcannulas was 7.3min. For active removal using a specially designed 25G cannula for 1000 and 5000 cSt silicone oil, the mean time was 3.3min and 10.3min, respectively[13-14]. For active removal using a specially designed 23G cannula for 5000 cSt silicone oil, the mean time was 4.54min[9]. Patwardhan *et al*[15] reported that the time needed for the passive removal of 1000 cSt silicone oil using two 23G microcannulas was 6.9min. Song *et al*[16] reported that the mean time for the active removal of 5000 cSt silicone oil using a 23G microcannula was 6.8min. Using an external vacuum pump, the mean SOR time was decreased to 7.12±1.27min for 5700 cSt silicone oil[17]. Through 23G trans-conjunctival sutureless vitrectomy surgery, Siyal *et al*[18] reported a mean time of 7.3min for 1000 cSt passive SOR and 12-15min for 5000 cSt silicone oil. In this study, the SOR time for 5700 cSt silicone oil was 4.8±1.2min, indicating that the TO is a time-saving method.

The potential disadvantage of sutureless vitrectomy is postoperative wound leakage. Zafar *et al*[19] reported transient hypotony in 7.3% of the examined eyes. Moreover, Song *et al*[16] reported that nine of 48 eyes (18.75%) required additional sutures intraoperatively, while three eyes (6.25%) developed postoperative hypotony. We sutured all the sclerotomy sites to prevent postoperative hypotony, and obtained a safe result (no occurrence of hypotony). The incidence of retinal redetachment after SOR was reported to be 0.02%-20%[6-7,19-20]. In this study, this incidence was 4.8% in each group, indicating that this new method did not increase the incidence of retinal re-detachment. Furthermore, there were no other postoperative complications (*e.g.*, vitreous hemorrhage, dislocated IOL, or endophthalmitis) observed. According to these findings, the TO is a safe method.

The present study was characterized by some limitations, namely a relatively small sample size and short follow-up time. Future investigations with larger controlled cases and longer follow-up time are warranted to validate the efficacy and safety of this technique.

In conclusion, our findings indicated that the TO method is a simple, effective, time-saving, and safe method for SOR with phacoemulsification and IOL implantation.

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Conflicts of Interest: Zhang X, None; **Pan YJ,** None; **Song ZY,** None.

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