• Clinical Research •

Phacoemulsification combined with transpupillary removal of silicone oil and intracapsular intraocular lens implantation

Yu-Cheng Zhu, Dong-Qing Yuan, Ping Xie, Xiao-Yi Liu, Song-Tao Yuan, Qing-Huai Liu

Department of Ophthalmology, the First Affiliated Hospital with Nanjing Medical University, Nanjing 210029, Jiangsu Province, China

Co-first authors: Yu-Cheng Zhu and Dong-Qing Yuan

Correspondence to: Dong-Qing Yuan. Department of Ophthalmology, the First Affiliated Hospital with Nanjing Medical University, Nanjing 210029, Jiangsu Province, China. wuyuleng@126.com

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Abstract

• AIM: To estimate the effectiveness of phacoemulsification and foldable intraocular lens (IOL) implantation combined with transpupillary silicone oil removal.

• METHODS: There were 168 eyes of 168 candidate patients with cataract and silicone oil-filled eyes recruited in our study. All of the patients received the intraocular silicone oil removal surgery by transpupillary drainage and cataract extraction by phacoemulsification. Then the IOL implantation were also performed through corneal incision.

• RESULTS: The surgery was successfully completed in all eyes. Best corrected visual acuity (BCVA) and postoperative complications were recorded in three months after surgery. There were 143 eyes with BCVA improved, otherwise 25 eyes remained stable at the last follow-up visit. The mean BCVA statistically improved from 20/400±0.02 to 20/100±0.15 (P<0.001) and mean postoperative IOP was 13.85±2.18 mm Hg (P=0.415). No intra-operative complications were reported.

• CONCLUSION: Phacoemulsification combined with transpupillary removal of silicone oil is a safe and simple effective method. In general, it enables quick recovery of visual acuity with less complication rate.

• KEYWORDS: phacoemulsification; posterior capsulorhexis; silicone oil removal

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INTRODUCTION

Silicone oil filling in vitreous is a common method to withstand the retina and maintain the intraocular pressure (IOP) in posterior eye surgery. However, there are still several potential complications after silicone oil filled, such as silicone oil emulsification, secondary glaucoma, cataract, and corneal degeneration[1-3]. Therefore, it is suggested that the silicone oil should be removed as its tamponade effect is no longer needed[4]. The occurrence of posterior subcapsular cataract with silicone oil tamponade is closely related to the retention time of silicone oil contact with the lens, mostly in the 6-12mo after operation. The pathogenesis for this disorder have not been elucidated. At present, there is no effective preventive measures for postoperative cataract: lie prostrate as long as to reduce the contact time between silicone oil and lens; remove the silicone oil as soon as the retinal stabilization. Once the secondary cataract occurs after surgery, it is recommended that a combined operation will be needed with cataract extraction and removal of silicone oil.

There are several studies show that combined phacoemulsification and transpupillary silicone oil through a planned posterior capsulorhexis is a simple and less invasive technique, which with less trauma and better reserved of blood-aqueous barrier function[5-6]. Silicone oil removal without the use of a separate infusion mechanism was described by Jonas *et al*[7] who used manual irrigation and aspiration (I/A) through a posterior capsulorhexis and a clear corneal wound for silicone oil removal. El Baha *et al*[6] described a new technique that the removal of silicone oil combined with phacoemulsification and intracapsular foldable intraocular lens (IOL) implantation using illuminated 23-gauge infusion system. In our study, we report a new method of silicone oil removal in combination with phacoemulsification and IOL implantation with a standard or toric IOL, through a posterior continuous curvilinear capsulorhexis (PCCC).

SUBJECTS AND METHODS

Patients Selection There were 168 eyes of 168 patients (107 men and 61 women) included in our study, who consecutively underwent cataract extraction and simultaneous removal of silicone oil from July 2011 to December 2013 at the first affiliated hospital with Nanjing Medical University. All

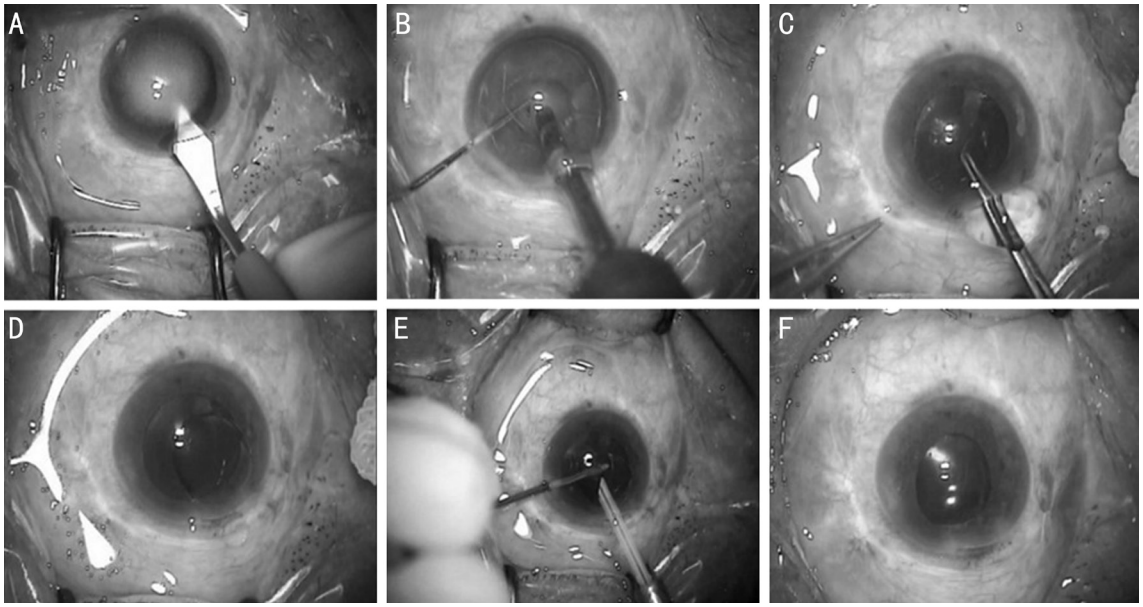

Figure 1 Cataract extraction by phacoemulsification combined transpupillary silicone oil drainage through corneal incision under local anesthesia and without a pars plana infusion line A: Placement of the inferotemporal micro-cannula 3 mm from the corneoscleral limbus; B: Hydrodissection of the lens nucleus was performed followed by phacoemulsification with irrigation and aspiration of the lens material; C: The posterior capsule was opened with a diameter of approximately 2.5 mm to 3.5 mm in the central region of the posterior lens capsule using a capsulorhexis forceps; D: Since silicone oil is buoyant over water, it could float upon the surface; E: A 20-gauge intravenous catheter without needle core was applied to actively aspirate the silicone oil. The illuminated infusion cannula was used by 22-guage intravenous infusion needle that inserted through the side port incision; F: After removal of all silicone oil, a soft acrylic foldable lens was injected in the capsular bag.

patients accepted pars plana vitrectomy (PPV) by the same operator, and also had 5700-centistokes silicone oil injection 1mo to 14mo before removal of the silicone oil. After thorough eye examination, including extraocular movements, visual acuity, pupillary evaluation, and funduscopy, all patients had cataract which impair visual acuity that need to be extracted and the retina was stable without retinal proliferation or macular pucker, as viewed through an indirect ophthalmoscope. Membranectomy were excluded proliferation or macular injury. Ultrasonic examination of posterior segment assessment was also performed in patients with dense cataract. Patients needed additional treatment such as endolaser photocoagulation or in the study. All patients involved in this study gave their informed consent. The research adhered to the tenets set forth in the Declaration of Helsinki.

Data Source All patients with combined cataract phacoemulsification and silicone oil removal were given clinical comprehensive analysis, the observation index includes: 1) preoperative Snellen best-corrected visual acuity (BCVA); 2) primary retinal diagnosis; 3) operation scheme before surgery; 4) interval between PPV with silicone oil injection and cataract extraction; 5) preoperative IOP; 6) exact measurements of keratometry, anterior chamber depth and axial length using IOL Master (IOL Master V1.1; Carl Zeiss Meditec, Jena, Germany). In most eyes, SRK-T formula in IOL Master (silicone-filled program) was used to calculate IOL power before starting the surgery[8]. All patients were evaluated post-operatively using the same preoperative tests. Visual acuity and IOP measurements were performed at the first postoperative day and in all follow-up visits at least 3mo.

Surgical Technique All patients underwent silicone oil removal combined cataract extraction by phacoemulsification, and silicone oil drainage was transpupillary through corneal tunnel incision under local anesthesia and without a pars plana infusion line (Figure 1). A 3-mm width corneal incision was made and anterior capsulorhexis was performed (Figure 1A). Phacoemulsification with irrigation and aspiration of the lens material (Figure 1B). The posterior capsule was opened with a diameter of approximately 2.5 mm to 3.5 mm in the central region of the posterior lens capsule using a capsulorhexis forceps (Figure 1C). Since silicone oil is buoyant over water, it could float upon the surface (Figure 1D). A 20-gauge intravenous catheter (Becton Dickinson Infusion Therapy Systems Inc., USA) without needle core was applied to actively aspirate the silicone oil using Millennium vitrectomy system (Bausch & Lomb, Incorporated, USA) with a negative pressure of 500 mm Hg through the PCCC. The illuminated infusion cannula, which was used by 22-guage intravenous infusion needle (Becton Dickinson Infusion Therapy Systems Inc., USA), connected to balanced salt solution was inserted through the side port incision (Figure 1E). The bevel of the tip had to be facing posteriorly to avoid damage to the corneal endothelium by the fluid inflow. Since silicone oil is buoyant over water, scleral depression, eye and head positioning/rolling

were used to move the oil to a more central position beneath the posterior capsulorhexis, where it could be readily aspirated. After evaluation of ocular fundus to confirm that there is no detachment of the retina and complete removal of silicone oil, a soft acrylic foldable lens was injected in the capsular bag. Balanced salt solution was used to restore the globe to normal pressure (Figure 1F). For patients with silicone oil emulsion, the surgeon performed anterior chamber irrigation to remove the emulsified silicone oil droplets.

Statistical Analysis SPSS software (version 13.0 for Windows; SPSS Inc., IL, USA) was used for statistical analysis in this study. Visual acuity was recorded by logarithm of the minimum angle which converted from Snellen visual acuity. Arithmetic mean (±SD) for numerical data *t*-test was used. $P<0.05$ was considered to indicate significance.

RESULTS

There were 168 eyes of 168 patients (107 men and 61 women) included in our study. All patients were in 48y to 75y age range (mean±SD, 61.24±7.36y). The time intervals of silicone oil tamponade were from 30d to 415d (mean±SD, 240.9±59.2d). Of these patients who underwent PPV and silicone oil tamponade, 98 eyes had tractional diabetic detachment, and 70 eyes with complicated rhegmatogenous retinal detachment (containing Grade C proliferative vitreoretinopathy (PVR) in 22 eyes, giant hole in 18 eyes, posterior pole breaks retinal detachment in 19 eyes, tractional retinal detachment without PVR in 11 eyes).

All patients were the successfully completion of surgery. The silicone oil was completely removed from all eyes. There was no significant residual oil in the anterior chamber or in the vitreous cavity in the last follow up after surgery. The mean follow up period were 4.15±1.34mo (range, 3-6mo).

The mean preoperative IOP was range from 7 to 21 mm Hg (15.4±2.75 mm Hg), and the postoperative IOP at first day was range from 10 to 19 mm Hg (13.85±2.18 mm Hg) (P=0.415). There were 5 eyes occurring increase of IOP at one month after operation, which required intervention.

There was no serious intraoperative complications occurred. Corneal incision was closed without suturing and early postoperative hypotony in any eye. Early shallow anterior chamber and localized bleb was not seen. After 1wk of postoperation 3 eyes occured transient corneal edema and showed dramatic ameliorated after treatment. None postoperative complication was developed such as vitreous hemorrhage, choroidal detachment, dislocated IOL, or endophthalmitis.

Three eyes occured late recurrent retinal detachment 2mo after surgery because of PVR, which were re-operated on with PPV and silicone oil tamponade once again. In these 3 cases, removal of silicone oil was possible after 6, 10 and 8mo, respectively, and none recurrence of retinal detachment occured (during 3mo follow-up). There were 2 eyes with persistent macular edema by documented by fluorescein angiography and spectral domain optical coherence tomography, which was successfully treated by intravitreal triamcinolone injection.

There were 143 eyes with BCVA improved, otherwise 25 eyes remained stable at the last follow up visit. The mean BCVA statistically improved from 20/400±0.02 (range, 20/2000 to 20/200) to 20/100±0.15 (range, 20/800 to 20/25) (P<0.001).

DISCUSSION

PPV in combination with silicone oil tamponade is a widely used technique for retinal detachment repair. Silicone oils were successfully introduced to retinal surgery by Cibis *et al*[9] in 1962. Along with the widespread use of silicone oil for retinal tamponade came the observation that silicone oil induces cataract formation. The relationship between silicone oil and posterior subcapsular cataracts is well documented and occurs in 100% of eyes in which the oil remains *in situ* for more than 3mo. Even if lenses appear clear at the time of oil removal, 60% develop visually significant cataracts within 2y[10-11]. The exact mechanism for cataract formation induced by silicone oil is unclear. However, it may be related to the irritation of the posterior capsule by the oil[12] and to the induction of proliferation of the lens epithelium by the underlying complicated retinal detachment[13-14].

Previous studies have reported techniques for cataract extraction while the silicone oil removal in place. Others have demonstrated cataract phacoemulsification and silicone oil removal by 2 separate surgical sessions, some with or without IOL implantation. In 1995, Baer *et al*[15] were the first to describe a single surgical procedure for silicone oil removal and extracapsular cataract extraction. In 1998, Larkin *et al*[16] described concurrent silicone oil removal and phacoemulsification in a series of 34 eyes. Larkin's group used a separate infusion port that allowed active efflux of silicone oil. Silicone oil removal without the use of a separate infusion mechanism was lately described by Boshra *et al*[17], who used manual I/A through a clear corneal wound for silicone oil removal.

We describe a new method of combined silicone oil removal with phacoemulsification and intracapsular soft acrylic lens implantation through clear corneal wound. The unique advantage of our technique is being sutureless, and does not require the use of a separate infusion cannula or additional vitreoretinal incisions. We found that silicone oil removal using this mode was safe, effective, and efficient for silicone oil (5700 centistokes). In our surgical procedure, the silicone oil aspiration was actively and the illuminated infusion cannula was used by 22-guage intravenous infusion needle that inserted through the side port incision to maintain the anterior chamber. There were thus four significant advantages. First, the time

of contacting with corneal endothelium was controlled as the silicone oil was actively aspirated by 20-gauge intravenous catheter. Second, the illuminated infusion cannula was used by 22-guage intravenous infusion needle that inserted through the side port incision to establish stabilized IOP and minimize fluid turbulence inside the anterior chamber. Both implications were aimed to minimal endothelial cell loss. Third, the irrigation fluid by 22-guage catheter is directed parallel to the iris and not downward into the vitreous cavity, which would not increase the vitreous cavity pressure and reduce the small oil droplets floating. Fourth, as the flexible pipe the 20-gauge intravenous catheter turned easily to follow the tracks of small floating droplets and cleared up silicone oil droplets as much as possible. Furthermore, sutureless surgery avoids the local inflammatory reaction because of suture materials and eliminates the irritation from exposed sutures. This leads to less postoperative inflammation and faster patient rehabilitation[18-19]. In our procedure, the pars plana incisions were not needed and transpupillary silicone oil drainage through corneal incision, which would avoid potential sclerotomy-related complications.

Previous study reported that early removal of silicone oil after PPV would significantly increases the possibility of improved visual acuity[3]. In our study, the proportion of visual acuity improved was 85.1%, and stabilized was 14.9%. There is no significant difference of IOP levels between preoperation and postoperation on first day and afterward after surgery. There were 5 eyes (0.03%) occurring increase of IOP at one month after operation. Compared with previous study[6], our result was significantly decreased which might indicate that procedure was much safer and more effective than removal of silicone oil using illuminated 23-gauge infusion system.

In our study, 3 of 168 eyes (0.02%) occured late recurrent retinal detachment 2mo after surgery because of PVR, which were re-operated on with PPV and silicone oil tamponade once again. There was none final anatomical failure at the latest follow up. Previous study revealed that the redetachment rate after silicone oil removal was 16.5% in patients due to PVR[20]. This variation might result from the differences of sample size, the period of silicone oil tamponade, and the duration of follow-up time after surgery. We believe that retinal examination before and after silicone oil removal was much necessary. In addition, there was no keratopathy founded at postoperative examination in our study. After 1wk of postoperation 3 eyes (0.02%) occured transient corneal edema and showed obviously ameliorated after treatment, which could be construed as the prolonged phaco time. Boscia *et al*[21] reported the similar results that 2 of 34 eyes having transient corneal edema. Former research reported 25% of persistent macular edema after phacoemulsification combined with silicone oil removal through the posterior capsulorhexis tear. There were 2 eyes (0.01%) with persistent macular edema, which were cured thoroughly by intravitreal triamcinolone injection. We conceive that these complications arise were not recommended to the removal of silicone oil, but due to the problems with initial retinal disease.

In conclusion, cataract phacoemulsification combined with transpupillary removal of silicone oil *via* an anterior approach and intracapsular IOL implantation using a closed system and separation of I/A function is simple, less invasive, more effective, and safe. It enables a faster visual restored with fewer complications. We believe that transpupillary removal of silicone oil combined with phacoemulsification and IOL implantation might be a preferable operational method as it is efficacious with high safety coefficient and modest postoperative complication.

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