COMPARISON OF EFFECT OF SILICON OIL ON CENTRAL CORNEAL THICKNESS AND CORNEAL ENDOTHELIAL-CELL DENSITY

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ABSTRACT

Objective: To compare the mean changes in central corneal thickness (CCT) and corneal endothelial-cell density (CED) after removal of silicon oil (ROSO) using anterior (limbal) versus posterior (pars plana) approach in aphakic patients following successful retinal re attachment surgery.

Study Design: Randomized controlled trial.

Place and Duration of Study: Armed Forces Institute of Ophthalmology (AFIO) Rawalpindi, from Dec 2014 to Aug 2015.

Material and Methods: Sixty eyes of 60 aphakic patients who underwent removal of silicon oil from December 2014 to August 2015 in AFIO after successful retinal re-attachment surgery were analysed. Thirty eyes underwent removal of silicon oil through anterior (limbal) approach (group1) and 30 eyes through posterior (pars plana) approach (group-2). Pre-operative central corneal thickness and corneal endothelial-cell density was measured and compared with central corneal thickness and corneal endothelial-cell density measurements 3 months after removal of silicon oil.

Results: Mean age of study population was 49.93 ± 5.18 years. Both groups were age and sex matched (p=0.694 and p=0.80 respectively). In group 1, mean change in CCT was 1.80 ± 6.58 micro meters (µm) and mean change in CED was 196.30 ± 33.78 cells per millimetres square (mm^2), while in group 2, mean change in CCT was 1.63 ± 8.96 µm and mean change in CED was 60.20 ± 39.75 cells/mm^2 after 3 months of ROSO. Mean change in CCT between two groups was not statistically significant (p=0.935), however, mean change in CED between two groups was statistically significant (p<0.001).

Conclusion: Removal of silicon oil through anterior (limbal) approach causes significant reduction in CED, as compared to posterior (pars plana) approach in aphakic patients following successful retinal re attachment surgery.

Keywords: Central corneal thickness, Corneal endothelial-cell density, Removal of silicon oil.

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INTRODUCTION

Silicon oil (SO) endotemponade during complex vitreo-retinal (VR) surgeries has become a standard technique with favourable success rate for retinal detachment (RD) surgery[1]. SO has the advantage of having lower surface tension at the water interface, being inert, less toxic, and having lesser side effects. SO with viscosities of 1000 and 5000 centistokes (CS) are being used by surgeons according to their preferences and required duration of endotemponade, despite evidence that there is no difference in temponading force of them[2,3]. Low viscosity SO are easy to handle and have easy removal from the vitreous cavity while higher viscosity SO are subject to decreased and delayed emulsification[2,3]. However, SO endotemponade is associated with complications such as cataract, hypotony, glaucoma, oil emulsification and SO keratopathy that merits its removal after 3-6 months of sustained retinal attachment[4,5].

Removal of silicon oil (ROSO) is a procedure that carries a definite risk of re detachment, cataract, glaucoma, vitreous haemorrhage, hypotony, corneal decompensation, phthisis bulbi, decrease in endothelial cell density and macular changes[5,6]. Various surgical techniques

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for ROSO have been described. In aphakic patients, ROSO can be done either through anterior limbal approach or through pars plana approach. Limbal approach for ROSO is beneficial in terms of less surgical time and lesser risk of pars plana sclerotomy related retinal tears and fibro vascular proliferation[7]. However this approach has potential deleterious effects on central corneal thickness (CCT) and corneal endothelial-cell density (CED). Specular microscopic evaluation of CED provides direct evidence of endothelial cell damage, while CCT provides indirect evidence of corneal compromise.

As SO is required to be removed after a certain interval, its removal further augments the deleterious effects on corneal endothelium. Passive silicone oil efflux through the limbal incision has more damaging effects on corneal endothelial cells. ROSO through active suction potentially restricts the damage of corneal endothelium by restricting extensive contact between the SO and corneal endothelium[7]. SO associated keratopathy encompasses corneal odema, band keratopathy, bullous keratopathy, corneal thinning, retro-corneal membrane formation, and irreversible corneal endothelial cell loss[9,12]. ROSO in aphakic eyes can be done through multiple techniques. Anterior or limbal approach involves creating a limbal incision, and passive efflux of SO through the incision after administration of balanced salt solution (BSS) through a pars plana port or through active suction of SO from pupillary area after making posterior capsulotomy. The advantage of this approach is less surgical time and less chances of sclerotomy related complications such as retinal breaks and fibro vascular ingrowth, but the risk of corneal endothelial damage is a grave concern[7]. The posterior approach involves making sclerotomy ports, and active/passive removal of SO from vitreous cavity. It is a bit lengthy procedure requiring closure of ports, and chances of damage to retina, but is much safer for corneal endothelium.

There is no local data available regarding effect of ROSO on corneal morphology, highlighting the need for a study to evaluate the effect of ROSO on CED and CCT in Pakistani population in order to determine which approach has less deleterious effects on cornea. The objective of this study was to compare the mean change in CCT and CED after ROSO using anterior (limbal) versus posterior (pars plana) approach in aphakic patients with successful retinal re attachment surgery.

MATERIAL AND METHODS

This was a randomized controlled trial carried out at Armed Forces Institute of Ophthalmology (AFIO) Rawalpindi from December 2014 to August 2015. After approval by the hospital ethical review committee, informed consent was taken from the patients prior to inclusion in the study. Non probability consecutive sampling technique was used and calculated sample size was 30 in each group keeping level of significance as 5, power of test as 80, population mean as 239.2, test value of mean as 86.7 and population SD as 54[7]. Aphakic patients between 20–70 years of age of either gender, with ≥3 months of SO endotemponade using 1000 CS SO, which underwent pars plana vitrectomy (PPV) for complex retinal detachment, were included. Patients with connective tissue disease, history of corneal disease, family history of glaucoma, history of contact lens wear during last 01 week, eyes with pars plana vitrectomy for complex retinal detachment due to penetrating injury, intraocular foreign body or endophthalmitis and presence of SO in anterior chamber (AC) were excluded. Subjects fulfilling the inclusion criteria underwent ophthalmic clinical examination including uncorrected and corrected distance visual acuity assessment, slit lamp examination with fund us examination and intraocular pressure (IOP) measurement. Adequate retinal re-attachment with 360^{o} laser photocoagulation up to the arcade was confirmed by consultant vitreo retinal surgeon through indirect ophthalmoscopy/ slit lamp biomicroscopy with 90 D lens in each patient.

Preoperative, CCT and CED were measured using Topcon SP 3000P Specular Microscope (Topcon Corporation, Tokyo, Japan). Average of three readings, each of CCT and CED were taken for analysis. Sampling bias was eliminated by analysing 100 cells in centre of each specular microscope photograph. Sixty consecutive patients requiring ROSO after successful retinal attachment were randomly divided in two groups using lottery method. Surgery was performed by single consultant VR surgeon in each patient on Constellation Vision Vitrectomy system (Alcon Labs Inc). All the surgical procedures were performed under local anaesthesia with retro bulbar injection of 5 ml mixture of 2% bupivacaine and 2% Lignocaine after dilation of pupil with 1% tropicamide eye drops. In patients undergoing ROSO through anterior approach (group-1), a 23G pars plana infusion line was placed at 3.5mm from the limbus in infero-temporal quadrant. A 2.5 mm corneoscleral incision was made at the 12 o'clock position with a phaco lance. By turning the infusion on, the SO was completely removed in all cases by passive efflux through superior limbal incision. After completion of ROSO, the anterior chamber was maintained with BSS. In patients undergoing ROSO through posterior approach (group-2), 2 or 3 pars plana 23G ports were made according to the situation and surgeon's preference. Infusion line was secured in infero-temporal port. After visualization of retina for adequate re-attachment, SO was extracted through active vacuum after turning infusion on. In some cases, SO was extracted passively by enlarging one of the superior ports to 20G in order to facilitate SO aspiration. After complete replacement of SO with BSS, 20G port was sutured with Vicryl 7.0 while 23G ports were self sealing. Post-operatively, all patients received antibiotic drops (moxifloxacin 0.5% TDS) and steroid drops (prednisolone 1% TDS) for 2 weeks. Postoperative evaluation was done on day 1, 2 week, 4 week, 8 week and 12 week time. CCT was measured at day 1 and 12 weeks post operatively, while CED was measured at 3 months follow up visit. All the relevant details including patient demography, ocular exam findings, intraocular pressure, and corneal parameters were endorsed on a pre-designed proforma.

Table-I: Group wise demographic and clinical data.

Variable	Group 1 (n=30)	Group 2 (n=30)	*p*-value
Age (Years) mean ± SD	50.20 ± 5.25	49.66 ± 5.18	0.662
Gender			1.0
Male	16 (53.3%)	16 (53.3%)	
Female	14 (46.7%)	14 (46.7%)	
Eye			0.791
Right	17(56.7%)	16(53.3%)	
Left	13(43.3%)	14(46.7%)	
Temponade duration (month) mean ± SD	6.70 ± 0.95	6.53 ± 0.89	0.477
Indication of surgery			0.980
RRD+PVR	12 (40%)	10 (33.3%)	
RRD+GRT	3 (10%)	3 (10%)	
RRD+IOFB	3 (10%)	3 (10%)	
Trauma	5 (16.7%)	5 (16.7%)	
ADED	7 (23.3%)	9 (30%)	

Statistical analysis of the data were done using SPSS version 17.0. Descriptive statistics i.e. mean ± standard deviation for quantitative

values (age, CCT, CED,) and frequencies along with percentages for qualitative variables (gender, type of initial retinal surgery, eye) were used to describe the data. Shapiro Wilk test was used to check normality of data. Chi square test was used for analysis of qualitative variables between groups. Independent sample t-test was used to analyse CCT and CED changes between two groups. Paired sample t-test was used to analyse within group changes in CCT and CED (before and after surgery). A $p<0.05$ was considered significant.

RESULTS

Mean age of study population was 49.93 ± 5.18 years. 32 (53.33%) were males, while 28 (46.66%) were females. Both groups were age and sex matched (table-I). Overall, right eye was operated in 33 (55%) and left eye in 27 (45%) patients. Primary vitreoretinal surgeries were performed for rhegmatogenous RD (RRD) with proliferative vitreo-retinopathy (PVR) in 22 (36.7%), RRD with giant retinal tear (GRT) in 6 (10%), RRD with intraocular foreign body (IOFB) in 6 (10%), RRD secondary to trauma in 10 (16.7%) and advanced diabetic eye disease (ADED) in 16 (26.7%) eyes (table-II). Mean duration of SO endotemponade was 6.70 ± 0.95 months for group-1 and 6.53 ± 0.89 months for group-2 (range 6-9 months). In group-1, mean pre-operative and 3 months postoperative CCT values were 533.83 ± 13.56 µm and 535.63 ± 12.36 µm respectively (p=0.145). Mean pre-operative and 3 months post-operative CED in group-1 was 2217.10 ± 168.29 cells/mm^2 and 2020.80 ± 168.96 cells/mm^2 respectively (p<0.001). In group-2, mean pre-operative and 3 months postoperative CCT was 532 ± 12.50 µm and 533.63 ± 7.57 µm respectively (p=0.327). Mean pre-operative and 3 months post-operative CED in group 2 was 2163.80 ± 160.92 cells/mm^2 and 2103.60 ± 157.56 cells/mm^2 respectively (p=0.001). CCT values were significantly higher in each group as measured on first post op day (p=0.001) as compared to pre op value, but returned to near pre-op values at 3 months follow up. Mean change in CCT in group-1 was 1.80 ± 6.58 µm (0.33%), while in group-2 was 1.63 ± 8.96 µm (0.30%) at 3 months follow up, and the difference was not statistically significant between groups (p=0.933). However, mean change in CED in group-1 was 196.30 ± 33.78 cells/mm^2 (8.85%), while in group-2 was 60.20 ± 39.75 cells/mm^2 (2.78%) at 3 months follow up, and the difference

Table-II: Central corneal thickness values before and after ROSO.

Variable	Group 1 (n=30)	Group 2 (n=30)	*p*-value
Pre-operative (µm) Mean ± SD	533.83 ± 13.56	532 ± 12.50	0.589
Post-operative – Day 1(µm) Mean ± SD	603.13 ± 25.23	564.46 ± 17.66	<0.001
Post-operative – 12 weeks (µm) Mean ± SD	535.63 ± 12.36	533.63 ± 7.57	0.453
Change in CCT at 12 Weeks(µm) Mean ± SD	1.80 ± 6.58	1.63 ± 8.96	0.933

Table-III: Corneal endothelial-cell density values before and after ROSO.

Variable	Group 1 (n=30)	Group 2 (n=30)	*p*-value
Pre-operative (Cells/mm2) Mean ± SD	2217.10 ± 168	2163.80 ± 160.92	0.215
Post-operative –12 Weeks (Cells / mm2) Mean ± SD	2020.80 ± 168.96	2103.60 ± 157.56	0.050
Change in CED at 12 Weeks (Cells / mm2) Mean ± SD	196.30 ± 33.78	60.20 ± 39.75	<0.001

was statistically significant between groups (p=0.001) (table-III).

DISCUSSION

Pars plana vitrectomy (PPV) was revolutionized with the idea of endotemponade using SO, first suggested by Paul Cibis and later on refined by Scott[1,8]. This lead to management RD with complex fibrosis and PVR, followed by filling the vitreous with SO which is an immiscible, non-expansible liquid, less buoyant, chemically inert, with a closer to vitreous refractive index[1]. SO exerts sufficient tamponade of the retina, allowing the anatomical success as well visual success in patients of complex retinal detachments. The duration of SO endotemponade varies from patient to patient, depending on the retinal status and SO related complications like cataract, hypotony, glaucoma, and oil emulsification, SO keratopathy, iritis and endophthalmitis[4,5,9]. Corneal complications of a complicated and prolonged VR surgery is a major concern for the surgeon especially using SO as temponading agent as it has toxic effects on corneal endothelium. Takkar et al pointed out that phakic status of the patient is the most significant and defining factor for corneal endothelial damage in VR surgeries with more profound corneal endothelial cell loss in aphakic as compared to phakic or pseudophakic eyes[10]. Cinar et al in their study reported decrease in CED after VR surgeries, with both oil and gas endotemponade, however protective effect of intact lens was observed[11]. Goezinne et al, who investigated five groups of patients for 12 months after vitrectomy with SO temponade, reported the highest loss in CED in aphakic eyes (39.2%), followed by pseudophakic eyes (19.2%) that underwent cataract surgery during the follow-up period[4].

In our study, mean change in CCT was 1.80 ± 6.58 µm and mean change in CED was 196.30 ± 33.78 cells/mm^2 in eyes that had ROSO through anterior approach, whereas, mean change in CCT was 1.63 ± 8.96µm and mean change in CED was 60.20 ± 39.75 cells/mm^2 in eyes that had pars plana approach for ROSO. Ivastinovic et al evaluated limbal and pars plana approach of ROSO in aphakic eyes and found the CED significantly decreased using both surgical methods (p<0.001). After limbal ROSO, the ECD loss averaged 239.2 ± 86.7 cells/mm^2 (13.9%) in contrast to 86.7 ± 22.4 cells /mm^2 (5.0%) after pars plana approach[7]. Arikan et al evaluated the effect of ROSO on CCT in aphakic and pseudophakic eyes prospectively and found that active ROSO either by anterior or posterior approach did not affect the CCT[12]. Boscia et al reported about 11.2% decrease in CED at 6 months after combined phacoemulsification and passive trans pupillary ROSO compared to 8.3% loss of CED in the control group with phacoemulsification alone[13]. Cacciatori et al evaluated the influence of combined clear corneal phacoemulsification and ROSO via anterior approach on corneal endothelium and found out that average endothelial cell loss was 6.7%[14]. However, Wadhwa et al reported about equal CED decrease of approximately 50 cells /mm^2 at 3 months after limbal and pars plana ROSO using active suction in aphakic eyes[15]. Apart from the conventional limbal or pars plana approach for ROSO, few other techniques have been described, but their effects on corneal morphology is yet to be confirmed[16,17]. Our study had limitations, like less number of patients in both groups, not keeping an account of surgery time, using only anterior approach in aphakic patients where literature shows more damage to endothelium.

CONCLUSION

Removal of silicon oil through anterior (limbal) approach causes significant reduction in corneal endothelial-cell density, as compared to posterior (pars plana) approach in aphakic patients following successful retinal re attachment surgery.

Disclosure

No author has a financial or proprietary interest in any material or method mentioned, neither the article presented in any conference,

seminar, and symposium before submission to PAFMJ.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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