International Journal of Medical Ophthalmology

E-ISSN: 2663-8274
P-ISSN: 2663-8266
www.ophthalmoljournal.com
IJMO 2023; 5(2): 113-121
Received: 09-07-2023
Accepted: 16-08-2023

Omar Mohamed Massoud
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

EL-Saied Ebrahim El-Dessouky
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Yasser Ragab Serag
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Mostafa Abdellatif Abo El Enin
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Corresponding Author:
Omar Mohamed Massoud
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Correlation of macular optical coherence tomography pattern and visual recovery after vitrectomy with silicone oil for retinal detachment

Omar Mohamed Massoud, EL-Saied Ebrahim El-Dessouky, Yasser Ragab Serag and Mostafa Abdellatif Abo El Enin

DOI: https://doi.org/10.33545/26638266.2023.v5.i2b.163

Abstract
Background: Silicone oil (SO) is commonly employed as a durable replacement for the vitreous substitute following vitreoretinal surgery to treat retinal detachment accompanied by significant proliferative vitreoretinopathy. The aim of the work was to correlate macular optical coherence tomography (OCT) pattern and visual recovery after vitrectomy with SO for retinal detachment.
Methods: This interventional, prospective, comparative study included 60 patients aged up to 18 years old, both sexes, with retinal detachment and had done pars plana vitrectomy (PPV) and used SO as tamponade. Al participants were distributed into two equal groups: The first group presented with rhegmatogenous retinal detachment (RRD), up to eighteen participants were macula On, while the remaining twelve were macula Off and Group II: presented with tractional retinal detachment involving the macular area.
Results: Correlation between multifocal electroretinography (MFERG) and OCT signs there is marked depression in conduction of MFERG because of silicone filled eye. In comparison between central foveal thickness at postoperative month-3 and MFERG, there was no statistically variation among both groups since there was marked depression of amplitude and prolonged latency of P1in both groups. In group I all patients postoperative by 3 months gained improvement in the acuity of vision over 20/200, group II P1 latency in patients with visual acuity (VA) better than 20/200, there was no marked variation between both groups.
Conclusions: Performing non-contact OCT before the removal of SO is important. OCT is very helpful in decision making of timing of SO removal. The condition of the macula whether macula on or off preoperatively is the most important factor in predicting visual outcome.

Keywords: Macular optical coherence, tomography pattern, vitrectomy, silicone oil, retinal detachment

Introduction
Silicone oil (SO) is commonly utilized as a durable replacement for the vitreous humor post vitreoretinal surgery to manage retinal detachment accompanied by significant proliferative vitreoretinopathy. The rationale for the removal of SO following a period of tamponade is mostly due to the occurrence of time-dependent issues related to it [1].

Following vitreoretinal surgery involving the use of silicone oil (SO), postoperative echographic evaluation encounters difficulties due to the ultrasonic characteristics of the SO. This type of virtual replacement results in echographic artifacts, including elongation of the echogram and ultrasound attenuation. Consequently, the interpretation of ultrasound images of the eye filled with SO is challenging and does not provide information regarding the presence of macular edema and epiretinal macular membranes, which are likely the primary factors contributing to poor functional outcomes despite favorable anatomical results [2].

Post-surgery, the level of visual acuity differs from one patient to another, even if there is evidence of retinal reattachment and a healthy posterior pole as observed during ophthalmoscopy [3]. Post-surgery, the level of visual acuity differs from one patient to another, even if there is evidence of retinal reattachment and a healthy posterior pole as observed during ophthalmoscopy [3]. Optical coherence tomography (OCT) is a noncontact and non-invasive method that utilizes light to get cross-sectional images of the eye [4].

The apparent reflectivity obtained by OCT is a composite of the actual reflectivity as well as the scattering and absorption properties of the media over it. Additionally, abnormalities in the vitreous body can potentially impact this reflectivity [5].

Using this method for retinal analysis offers enhanced precision and has the capability to identify cysts in instances of macular edema, serous subfoveal retinal detachment, foveal atrophy, or early stages of epiretinal membranes in eyes following retinal detachment surgery, even when ophthalmoscopy indicates that the fovea is attached [6].

Consequently, Optical Coherence Tomography (OCT) can have a significant impact on monitoring individuals who experience unclear vision impairment following vitrectomy. Although the latest OCT technology provides a clear view of the photoreceptors and other retinal layers, it is theoretically possible that a functional assessment could be even more effective in detecting impairments in the photoreceptors. These impairments may hinder visual improvement after treatment, as functional changes can still occur even if the OCT retinal examination appears normal [7].

The multifocal electroretinography (MFERG) responses primarily originate from the cone photoreceptors and its pathway [7], sthis technique has been studied as a means to evaluate retinal function in macular diseases and to predict vision improvement following surgery [8], However, the density of retinal response after surgery can differ among eyes with similar visual acuity. This discrepancy may be attributed to localized retinal changes that could reduce the amplitude of perifoveal mfERG without affecting visual acuity, as well as the variability in mfERG measurements between examinations [9].

This work aimed at establishing a correlation between macular OCT pattern and visual improvement following vitrectomy with SO for retinal detachment.

Patients and Methods

This interventional, prospective, comparative study included 60 patients aged up to 18 years old, both sexes, with retinal detachment and had done pars plana vitrectomy (PPV), using SO as tamponade. The study was done from July 2020 to January 2022 after approval from the Ethical Committee Tanta University Hospitals, Tanta, Egypt. We gathered an informed written consent from all participants.

Exclusion criteria were patients with media opacity that prevents imaging, pediatric age group (age < 18 years), eyes with previous macular pathology as macular hole, myopic traction maculopathy and epiretinal membrane, patients with history of trauma, patients with recurrent retinal detachment and patients with proliferative vitreoretinopathy (PVR) > grade C.

The patients were divided into two equal groups: Group I: presented with rhegmatogenous retinal detachment (RRD), 18 patients were macula on, and 12 patients were macula off and Group II: presented with tractional retinal detachment involving the macular area.

All participants went through the process of ocular examination [taking a detailed history, slit-lamp examination, auto-refractometer, best corrected visual acuity measurement, intraocular pressure measurement by applanation tonometer, ophthalmoscopy fundus examination, ocular ultrasound before the operation and colored fundus photography].

Multifocal ERG post vitrectomy by three months: Using RetiMax device (CSO, Pisa, Italy) in accordance with international society for clinical electrophysiology of vision (ISCEV) guidelines.

Patients' preparation

Maximal pupillary dilatation was done with combination of cyclopentolate 1% and phenylephrine 10%. In accordance with the ISCEV standards the patients were permitted a dark-adaptation period of about 20 minutes. Each patient was comfortably positioned in front of the pattern stimulator display with chin resting on chinrest place at 30 cm in order to subtend the correct visual angle. Optical correction for the testing distance was used to ensure optimal visual acuity at the testing distance from the stimulus source. The height of the table was adjusted in order to provide the correct alignment of the patient eye with the center of the display during the examination. The tests were performed separately for each eye. The eye not being examined was covered during testing of the other eye. All the patients were informed about the test procedure in order to obtain their maximum cooperation. They were urged not to blink when the flash stimulus appears to avoid artifacts.

Electrodes application

Before applying the electrodes to the patient, the skin was cleaned thoroughly at the electrode application points by skin prep gel. Nuprep® (Weaver and company) was used in this study. Alcohol or other products were not used to avoid irritating the patient's skin. The electrodes were disinfected before each use. These electrodes were applied to the skin with a specific conductive electrolytic paste in order to ensure the best electrical conductivity and contact between the electrodes and the patient's skin. Only a moderate quantity of paste was used. Ten 20® (Weaver and company) was used in this study. There are 5 electrodes, 1 green (ground) electrode, 2 black (-) electrodes and 2 red (+) electrodes. The 2 black (-) reference electrodes were positioned on the skin near the outer canthus while the ground electrode was positioned on the forehead. These are skin electrodes. They were applied only to healthy skin. The skin electrodes used in this study were Ag/AgCl Silver cup electrodes. The green wire was connected to the preamplifier common connector socket and the black wires were connected to the connectors marked (-), with Right connected to the right eye outer canthus and Left to the left eye outer canthus. The 2 red (+) active electrodes used were (HK-Loop electrodes) with their two limbs made of thin conductive fibers were widely separated and hooked in the lower fornix while taping the leads to the cheek to ensure their stability. The red wires were connected to the connectors marked (+), with Right connected to the right eye and Left to the left eye**.** Topical anesthesia of the cornea with 0.4% benoxinate hydrochloride was done to allow HK-Loop electrodes to be placed in the lower conjunctival fornix without irritation.

Recording procedure

Before beginning the test, the impedance was checked every time to check electrode-patient connection. The contact impedance was measured for each electrode applied to the exception of the common electrode. The ideal impedance value for each electrode is less than 3 kilohms. Values of less than 5 kilohms are indicative of good electrical contact. Impedance values exceeding 10 kilohms are indicative of insufficient contact quality. For good test reliability, it was important that the electrodes make good contact with the patient. In this study electrical impedance was smaller than 5 kilohms for all electrodes. During recording of the test, the patients were urged to keep their eyes on the center of the screen where a red central-fixation cross 2 mm in diameter was used to help them fixate. They were also told to pay maximum attention to the stimuli presented on the screen, and to not blink during presentation of the flash stimuli. The mfERG responses were recorded monocularly using a pseudorandom m-sequence with a stimulus matrix of 61 scaled hexagonal elements displayed on a pattern stimulator lamina cribrosa deformation (LCD) display subtending 30° on either side of fixation. During stimulation, each element was either black or white (99% contrast). The recording parameters were in accordance with ISCEV standards and guidelines. The resultant mfERG waveform was composed of the first negative N1 wave, positive P1 wave and second negative N2 wave.

Color map is used to indicate retinal thickness in the region under analysis Green (thickness within normal regarding age and sex), yellow (moderate thinning), red (severe thinning), orange (moderate thickening) and purple (severe thickening).

The macular map divides the region into a central disc and two concentric rings divided into four quadrants. The analysis program reports the corresponding mean thickness in each of the areas. The scan of normal retina in the macular area appears green (200 to 250 microns).

Statistical analysis

The statistical analysis was accomplished with SPSS v26 (IBM Inc., Chicago, IL, USA). The quantitative variables were expressed as the mean and standard deviation (SD) and compared between the two groups employing an unpaired Student's t-test. The qualitative variables were displayed as frequency and percentage (%) and were evaluated using the Chi-square test or Fisher's exact test, depending on the situation. The Pearson correlation coefficient (r) was computed to assess the strength and direction of the relationship between two continuous numerical variables, with the condition that at least one of them follows a normal distribution. A two-tailed P value less than 0.05 was deemed to be statistically significant.

Results: Regarding demographics (age and sex) and surgery type, there was no significant variation among both group (p>0.05). Regarding DM, HTN, DM duration and duration of detachment, there was marked variation among the two study groups (p<0.001). Regarding number of tears in group I there was 23 (76.7%) patients presented by single break and 7 (23.3%) patients presented by multiple breaks while in group II the 3(100.0%) patients that presented by combined TRD and RRD were all single breaks. Baseline visual acuity (Log MAR) was significantly better in group I (1.66±0.80) as compared to group II 2.05±0.28 (P = 0.016). However, when comparing the percentage of eyes that had visual acuity better than 20/200, there a profound difference among group I (40%) and group II (0%) (p<0.001). Table 1

Table 1: Demographics data, medical history, surgery type, DM duration, comparison duration of detachment in days and number of retinal breaks and baseline visual acuity in both study groups

		Group I RRD (n=30)	Group II TRD (n=30)	P-value
Age (Years)		54.6±9.4	57.1±13.7	0.413
Sex	Female	18 (60.0%)	12 (40.0%)	0.196
Medical history				
None		24 (80.0%)	0 (0.0%)	<0.001*
DM		0 (0.0%)	9 (30.0%)	<0.001*
DM + HTN		6 (20.0%)	21 (70.0%)	<0.001*
Surgery type				
PPV		24 (80.0%)	27 (90.0%)	0.472
Phacoemulsification + PPV		6 (20.0%)	3 (10.0%)	
DM duration				
DM duration (years)		5.4±2.5	15.1±4.1	<0.001*
Comparison duration of detachment in days and number of retinal breaks				
Detachment duration (Days)		8.2±6.8	36.4±16.0	<0.001*
Number of retinal breaks	Single Break	23 (76.7%)	3 (100.0%)	0.641
	Multiple Breaks	7 (23.3%)	0 (0.0%)	
Baseline visual acuity				
Baseline VA: Log MAR		1.66±0.80	2.05±0.28	0.016*
Baseline VA: Better than 20/200		12 (40.0)	0 (00.0)	0.001*

Data are presented as mean ± SD or frequency (%). *Significant P value<0.05, RRD: Rhegmatogenous retinal detachment. TRD: Tractional retinal detachment. DM: Diabetes mellitus. HTN: Hypertension, PPV: Pars plana vitrectomy, DM: Diabetes mellitus, VA: Visual acuity, MAR: Medication administration record.

33(55%) of the operated eyes were right and 27 (45%) eyes were left In Group I, there was 18 (60%) eyes right, and 12 (40%) eyes left while in Group II there was 15 (50%) eyes right, and 15 (50%) eyes Left. At baseline, 45 eyes (75%) were phakic and 15 eyes (25%) were pseudophakia. In Group I there was 24(80%) eye phakic and 6(20%) eyes pseudo phakic while in Group II there was 21(70%) eye phakic and 9(30%) eyes pseudophakic. In Group I, 18(60%) eyes had macula on RRD and there were 6 patients presented with VH due to retinal breaks and 12(40%) eyes had macula off RRD. In group II (30 eyes), 21 eyes had combined vitreous hemorrhage and TRD, 6 eyes had TRD, 3 (5%) eyes had combined RRD and TRD

Table 2: Baseline diagnosis in both study groups

Diagnosis	Group I RRD	Group II TRD
TRD	0 (0.0%)	6 (20.0%)
TRD + VH	0 (0.0%)	21 (70.0%)
TRD + RRD	0 (0.0%)	3 (10%)
RRD Macula On	18 (60.0%)	0 (0.0%)
RRD Macula Off	12 (40.0%)	0 (0.0%)

Data are presented as mean ± SD or frequency (%), RRD: Rhegmatogenous retinal detachment. TRD: Tractional retinal detachment. VH: Vitreous hemorrhage.

Regarding number of retinal breaks, there was a slight variation between both subgroup in group I (P-value=0.277). Regarding detachment distribution and central foveal thickness after 3 months from SO injection there was a profound variation between both subgroup in group I (p-value < 0.001). Table 3

Table 3: Number of retinal breaks, detachment distribution, PVR grade and central foveal thickness three months post-operative in group I

		Macula Off	Macula On	P-value
Number of retinal breaks	Single Break	11 (91.7%)	12 (66.7%)	0.277
	Multiple Breaks	1 (8.3%)	6 (33.3%)	
Detachment ddistribution (%)	Upper	0 (0.0%)	6 (33.3%)	<0.001*
	Lower	2 (16.7%)	12 (66.7%)	
	Subtotal	10 (83.3%)	0 (0.0%)	
PVR Grade (%)	PVR-A	1 (8.3)	17 (94.4)	<0.001*
	PVR-B	11 (91.7)	1 (5.6)	
Postoperative month-3 Central Foveal Thickness(μ)		376.5±100.8	220.0±48.6	<0.001

Data are presented as mean ± SD or frequency (%), *significant P value<0.05, PVR: proliferative vitreore6tinopathy.

Regarding Log MAR, intra-ocular pressure, central foveal thickness, there was a slight difference among both group (P value=0.234, 0.756, 0.830 respectively). Regarding visual acuity better than 20/200, there was profound difference between both group (P value=0.002). Table 4

Table 4: Post-operative Characteristics in both group

		Group I RRD (n=30)	Group II TRD (n=30)	P-value
3 Month postoperative VA	Log MAR	0.56±.30	0.68±0.46	0.234
	Better than 20/200	30 (100.0%)	21 (70.0%)	0.002*
1 Month post operative Central Foveal Thickness(μ)		263.4±74.1	256.3±100.4	0.756
3 Month post operative Central Foveal Thickness (μ)		282.6±106.4	276.2±122.6	0.830

Data are presented as mean ± SD or frequency (%). *Significant P value<0.05, RRD: Rhegmatogenous retinal detachment. TRD: Tractional retinal detachment.

In correlation between visual acuity preoperative and postoperative there was improvement in visu SO al acuity in both groups, in group I it was preoperative 1.66±0.80 and after 3months from SO injection it improved up to 0.56±.30 while in group 2 it was preoperative 2.05 ± 0.28and after 3months from SO injection it improved up to 0.68 ± 0.46 with p-value < 0.001.The central foveal thickness in both groups increased after SO injection it was in group 1 263.4±74.1 after 1 months and increased up to 282.6±106.4 after 3months while in group 2 256.3±100.4 after 1 month and increased up to 276.2±122.6 after 3months from the SO injection with p-value < 0.001. In comparison between macula on and macula off retinal detachment in group I the best corrected visual acuity improved in both groups but with more improvement in macula on patients with p-value of 0.022. The visual acuity is best improved with normal macular area more than patients presented more than patients presented with macular degeneration more than patients presented with cystoid macular edema more than patients presented with macular scar with P-value is 0.004. And in group II (TRD) there is correlation between OCT signs and best corrected visual acuity 3 months post-operative as there is no normal macular appearance in this group and best corrected visual acuity was achieved in CME more than foveal thinning more than patients presented by ERM with P-value 0.325. In correlation between MFERG and OCT signs there is marked depression in conduction of MFERG because of silicone filled eye. In comparison between central foveal thickness at postoperative month-3 and MFERG, no statistically variation was noted among both groups since there was marked depression of amplitude and prolonged latency of P1in both groups. Table 5

Table 5: Correlation between central foveal thickness and postoperative month-3 visual acuity, between postoperative month-3 visual acuity, between best corrected visual acuity at postoperative month-3 and OCT signs in groups

Group I	Baseline	3 month post-operative	P-value
VA: Log MAR	1.66 ± 0.80	0.56±.30	<0.001*
	Month 1	3 Month post-operative	
Central Foveal Thickness	263.4 ± 74.1	282.6±106.4	0.013*
Group II	Baseline	3 Month post-operative	P-value
VA: Log MAR	2.05 ± 0.28	0.68±0.46	<0.001*
	Month 1	**3 Month post-operative**	
Central Foveal Thickness	256.3 ± 100.4	276.2±122.6	0.030*
Group I	Macula Off	Macula ON	P-value
Postoperative month-3 VA: Log MAR	0.7 ± 0.2	0.5±0.3	0.022*
OCT signs			
	N		
OCT macula at postoperative month-3 in group I			
Normal	18	0.47±0.32	
Abnormal	12	0.70±0.21	
Best corrected visual acuity at postoperative month-3 and OCT signs in group I			
Normal	12	0.60±0.31	
Macular Scar	6	0.90±0.10	
Cystoid Macular Edema	6	0.50±0.10	
Macular Degeneration	6	0.55±0.10	

Best corrected visual acuity at postoperative month-3 and OCT signs in group II		
Cystoid Macular Edema	18	0.72±0.53
Foveal Thinning	9	0.73±0.33
Epiretinal Membrane	3	0.30±0.10

Data are presented as mean ± SD, *significant p value<0.05, VA: visual acuity, OCT: optical coherence tomography, MAR: Medication administration record.

In correlation between postoperative month-3 best corrected visual acuity and P1 latency and amplitude in MFERG, there is prolonged latency and decrease amplitude in both surgical groups. In group I all patients postoperative by 3 months gained visual acuity better than 20/200 while in group II P1 latency in patients with VA better than 20/200, there was no significant difference between the two groups. In comparison between both the silicone filled eye and the other eye of the same patient, a marked statistical variation was reported among two eyes in both groups since there is prolonged latency and decrease amplitude in silicone filled eye. Table 6

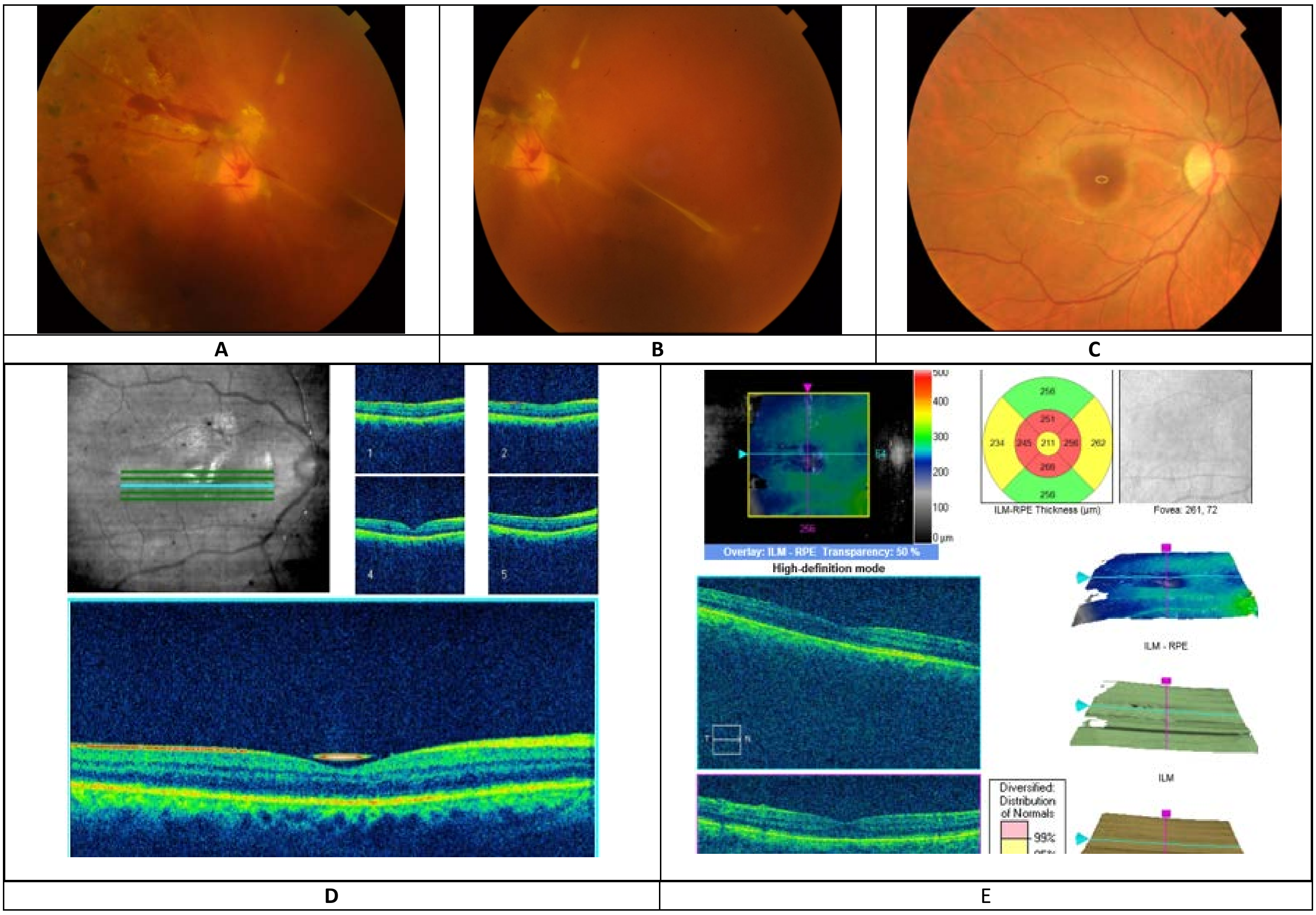
Table 6: P1 latency and amplitude in eyes with different visual acuity and comparison between P1 latency and amplitude at postoperative month-3 in silicone filled eye and visual acuity in group II (TRD) and between surgical eye and the other eye.

		VA Better than 20/200	VA 20/200 or Worse	P-value
P1 Latency		47.3±2.2	44.7±2.1	0.002
P1 Amplitude		1.8±0.2	1.8±0.1	0.911
At postoperative month-3 in silicone filled eye and visual acuity in group II (TRD).				
P1 Latency		47.1±2.2	44.7±2.1	0.013
P1 Amplitude		1.8±0.2	1.8±0.1	0.975
		Surgical Eye	**Other Eye**	**P-value**
Group I (RRD)	P1 latency	47.5±2.1	23.0±1.8	<0.001*
	P1amplitude	1.2±0.3	2.0±0.4	<0.001*
Group II (TRD)	P1 latency	46.4±2.4	23.3±3.2	<0.001*
	P1amplitude	1.1±0.2	1.2±0.4	<0.001*

Data are presented as mean ± SD, *significant p value<0.05, VA: visual acuity, RRD: Rhegmatogenous retinal detachment. TRD: Tractional retinal detachment

Cases

Case 1: Male patient aged 52 years old presented by recent onset of right eye field defect for one day with negative medical history and no history of trauma. The decision of PPV and SO injection in right eye was made. At postoperative month 3, the right eye BCVA remained 20/40 with appearance of PSC cataract and the retina is flat under SO.



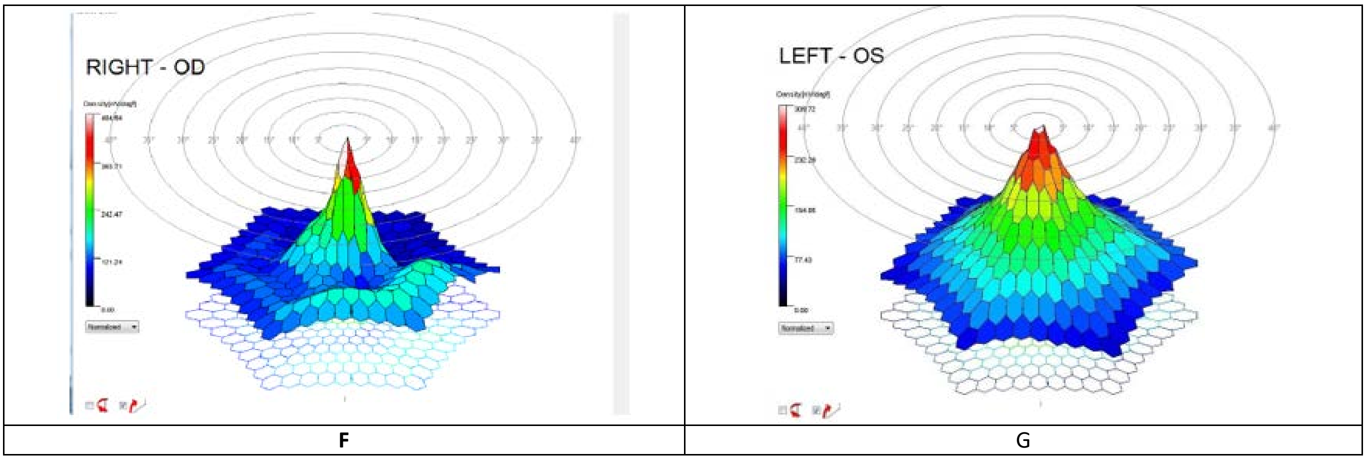
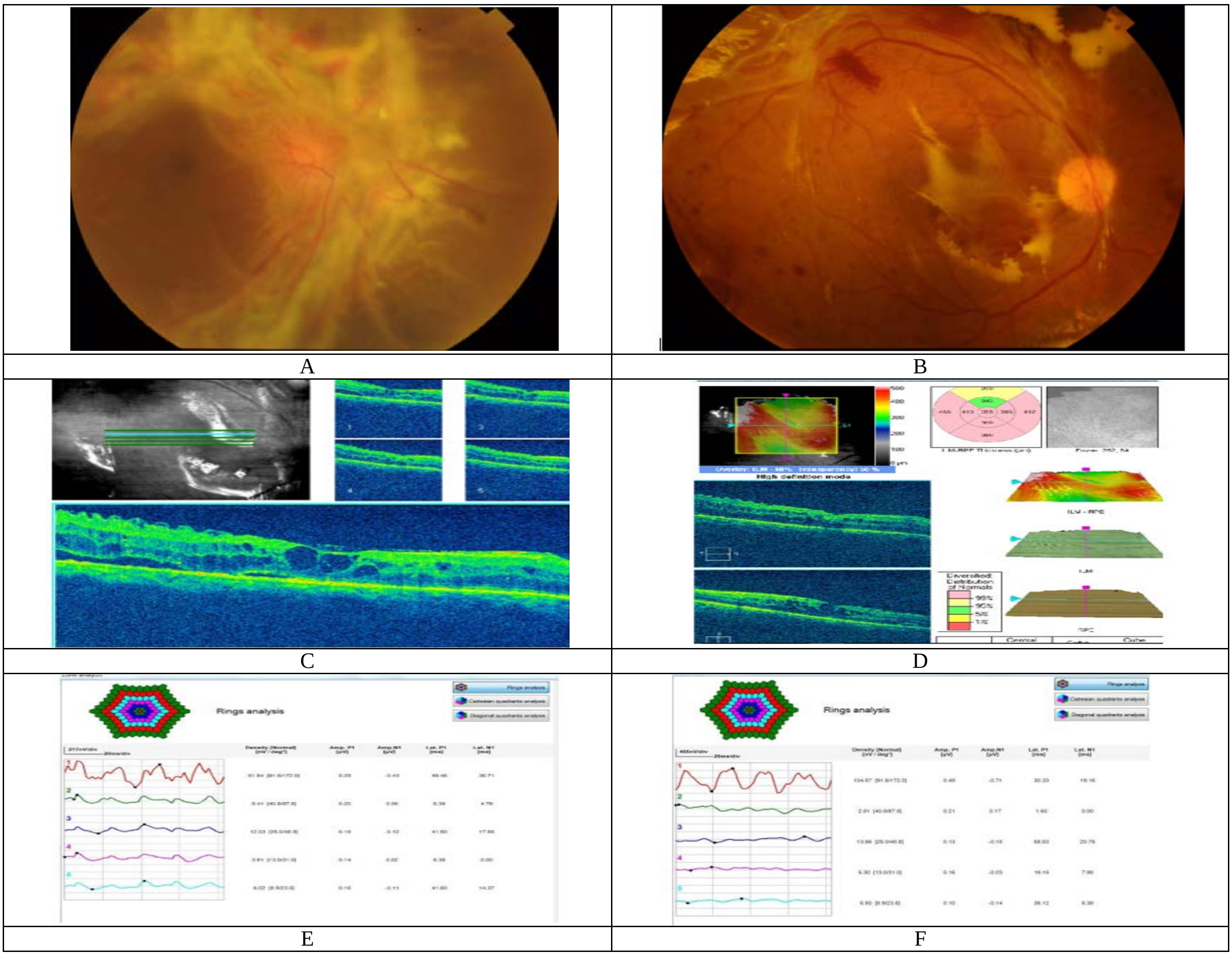


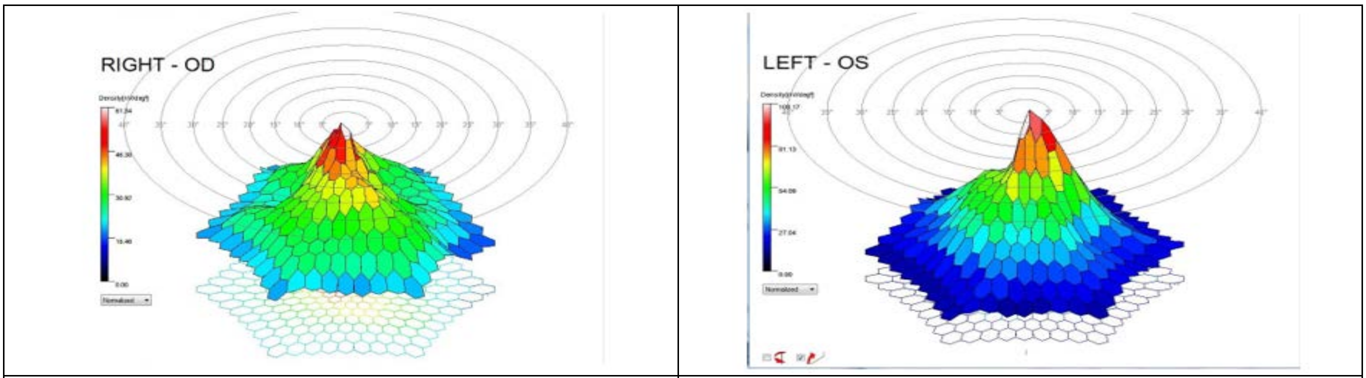
Fig 1: (A, B) Coloured photography of right eye shows lower retinal detachment with macula On (C): Coloured photography of right eye at postoperative month 3 shows retina flat under SO (D) OCT macula of right eye at postoperative month 3 shows myopic macular degeneration in silicone filled eye, CFT=211 um, F) 3D plot of mfERG of the right silicone filled eye at postoperative month3, G) 3D plot of mfERG of Left eye

Case 2

Female patient presented with diminution of vision in right eye for 2 weeks. The patient was known to be diabetic for 20 years with HBA1C of 10. She was also known to have ischemic heart disease. She had history of bilateral cataract extraction and IOL implantation.

The decision of right eye PPV and SO injection was made. At postoperative month 3, the BCVA improved from HM to 3 meters with flat retina under SO.





G	H

Fig 2: (A, B) Right eye colored photography shows combined tractional and rhegmatogenous retinal detachment, retina flat under SO, (C,D): OCT macula at postoperative month 3 shows CME, NSD and photoreceptor atrophy in silicone filled eye, CFT = 355 um,(E,F): Ring analysis of right and left eye MFERG post-operative 3 months shows prolonged latency and decrease amplitude in silicone filled eye, (G,H) 3D plot of mfERG of right and left silicone filled eye at postoperative month 3

Discussion

SO is commonly implemented as a durable intravitreal tamponade in vitreoretinal surgery for complex cases of retinal detachment (RD) with proliferative vitreoretinopathy (PVR) and proliferative diabetic retinopathy (PDR) [10].

SO offers superior structural reinforcement to preserve retinal attachment owing to its elevated viscosity. Nevertheless, the utilization of this substance has been linked to many side effects, such as cataract development [11], elevation of intraocular pressure (IOP) [12], emulsification of oil leading to secondary glaucoma [13], migration of oil underneath the retina [14] and the development of band keratopathy [15].

Regarding, OCT findings at 3 months after surgery the current study revealed that, OCT findings after 3months from SO injection in group I (RRD) there was 12 patients with normal OCT findings and 6 patients with macular scar, 6 patients with macular degeneration and 6 patients with CME, ERM, and NSD. And in group II there was no normal OCT findings, there was six patients with cystoid macular edema and there were 24 patients with combined ERM, disrupted IS/OS segment, NSD and foveal thinning. Amer [16]. Showed comparable OCT findings at 3 months after vitrectomy, 35.2% of the studied cases were normal, 18.3% of which developed ERM. The percentage of disrupted IS/OS was 22.2%, foveal thinning was 9.8%, cystoid edema was 9.8%, Diffuse macular edema was 7% and 4.2% showed localized macular edema. While Najpal *et al.* [17] addressed ERMs in 16.3% of cases while, macular edema was reported in 21.15% of cases, 7.6% of cases had sub foveal fluid, foveal thinning was documented in 5.7% of eyes.

Martinez-Castillo *et al.* [18] reported ERM in 10% of the PVR eyes. The lower incidence of ERM in their study is due to relying on clinical assessment for detection of ERM and performing OCT only to confirm the diagnosis in these cases.

In contrast to all the previous studies, Avitabile *et al.* [18] revealed that SO has no impact on measurements of macular thickness by OCT. This discrepancy can be explained by several causes; they went through OCT only 3 months following SO injection, excluded cases with ERM & macular holes and excluded cases with tractional RD due to diabetic retinopathy.

The current study revealed that, there was an increase in macular thickness by OCT measurement of the studied cases, but it was not statically significant difference. Central foveal thickness in both groups increased after SO injection. In group I, it was 263.4±74.1 after 1 month, and increased to 282.6±106.4 after 3months; while in group II, it was 256.3±100.4 after 1 month, and increased to 276.2±122.6 after 3months from the SO injection.

In contrast, Amer [16]. Revealed that reduction of CMT at 1 month and 3 months after PPV for RRD with SOT, was not statistically significant. He attributed the reduction in CMT to mechanical effect of SO on the macula or SO-related affection of macular microcirculation.

Christensen and la Cour [19]. Reported marked macular thinning of inner retinal layers (neuronal cell loss in the macular area) by OCT in SO-filled eyes in comparison with gas-filled eyes.

One of the most characteristic correlations in the present study was the correlation between macular thickness and macula on/off. The central foveal thickness after 3 months from SO injection there is increased foveal thickness in macula OFF (macular edema) group while it is normal in macula ON group. Similarly, Hong *et al.* [20] reported that at six months postoperatively, CMT was notably reduced in the detached eyes compared to the fellow eyes in cases of macula off rhegmatogenous retinal detachment (RRD). The thickness of the EZ-RPE was dramatically reduced in the detached eyes compared to the fellow eyes in the macula-off RRD group. Additionally, it was thinner in the outer retinal defect group compared to the intact outer retina group. Therefore, the condition of macula either on or off may have an important role in determination of the final results of macular thickness.

Electrophysiology has been assessed in animal models using eyes filled with SO. Nevertheless, the determining factor is the impact of SO itself on the measurement of the variables. Evaluating and assessments in eyes filled with silicon oil (SO) might be challenging. Several animal studies have observed a early and persistent decrease in 'b' wave amplitudes of mfERG following vitrectomy and SO injection. However, other research has reported no considerable decline in mfERG responses during the initial weeks after SO injection into vitrectomized animal eyes [21].

Human research is restricted to assessing mfERG during prolonged tamponade in vitreoretinal operations. The mfERG responses in these eyes exhibit a major reduction in comparison to the control group. There are differing opinions on the cause of this phenomenon. Some attribute it to the insulating action of the SO, while others think it is caused by retinal malfunction.

The insulating action of SO can be fully understood by studies assessing the electrophysiology immediately before and following SOR. The mfERG response shows a substantial rise after SOR, raising concerns about potential functional retinopathy [21].

The multifocal electroretinogram (mfERG) is affected at an early stage in the progression of different acquired retinal conditions that mostly affect the macula [22].

Nevertheless, the precise understanding of the cellular contributions to the human mfERG remains limited [23]. The current study demonstrates that consistent mfERG trace arrays can be produced in the presence of intravitreal SO. Furthermore, it illustrates the impact of SO in the vitreous cavity on the assessment of mfERG parameters. Initially, there was a notable reduction in the amplitude and delay in the response time of mfERG in eyes filled with SO, in comparison to the normal eyes [24].

The amplitude of the P1 wave increased quickly following SOR and subsequently maintained a consistent level. The implicit time remained mostly unchanged following SOR. Intravitreal silicone oil (SO) seems to possess an insulating property that hinders the spread of electric potentials. It could disrupt the measurement of the density of electrical potentials originating from the retina. However, it is possible that the synaptic transmission within the retina remains unaffected, resulting in no alteration in the implicit time.

Substantial findings were observed regarding the relationship between the condition of the macula and the parameters of the multifocal electroretinogram (mfERG). We hypothesize that the intravitreal SO may selectively disrupt the transmission of electric potentials between distinct retinal layers. The intravitreal SO may profoundly disrupt the contribution of electrical potentials density from the outer retinal layers at the macula [25].

Perhaps this is the reason why there was no difference in P1 amplitude and latency at baseline between macular-on and macula-off cases. However, macular-on individuals exhibited higher amplitudes following SOR. Nevertheless, this is merely a hypothesis and requires thorough research. In a similar direction, Lee *et al*. [26]. Revealed that the duration of SO tamponade did not exhibit a significant association with the extent of retinal thinning. Prior to this, Lou *et al*. [27] documented that the length of time that SO endo tamponade is applied has a notable impact on the level of retinal saturation as determined by oximetry.

Prolonged treatment of intravitreal silicone oil for over 9 months was observed to modify the saturation of the retina and result in constriction of the retinal arterioles. Histological studies have revealed that retinal alterations become evident only after a period of 6 months to 1 year following the use of SO tamponade [28].

Our study recommend that OCT macula is an essential tool to assess the macula in silicone filled eyes and should be done routinely before SO removal. More studies on the mfERG in silicone filled eye are needed to assess its rule.

Conclusions

Performing non-contact OCT prior to the removal of SO predict visual outcome by detection of different macular pathologies in silicone filled eyes. It also helps detect macular edema and thinning that could not be detected clinically or intraoperatively during SOR. This procedure should be performed routinely as follow up after PPV and SO endo-tamponade and prior to the removal of SO whenever the media allow. OCT is very helpful in decision making of timing of SO removal. The condition of the macula whether macula on or off preoperatively is the most important factor in predicting visual outcome.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

References

1. Abu El-Asrar AM, Al-Bishi SM, Kangave D. Outcome of temporary silicone oil tamponade in complex rhegmatogenous retinal detachment. Eur J Ophthalmol. 2003;13:474-81.
2. Shugar JK, De Juan E, Jr., McCuen BW, Tiedeman J, Landers MR, 3rd, Machemer R, *et al*. Ultrasonic examination of the silicone-filled eye: theoretical and practical considerations. Graefes Arch Clin Exp Ophthalmol. 1986;224:361-7.
3. Hagimura N, Iida T, Suto K, Kishi S. Persistent foveal retinal detachment after successful rhegmatogenous retinal detachment surgery. Am J Ophthalmol. 2002;133:516-20.
4. Panozzo G, Parolini B, Mercanti A. OCT in the monitoring of visual recovery after uneventful retinal detachment surgery. Semin Ophthalmol. 2003;18:82-4.
5. Mastropasqua L, Carpineto P, Ciancaglini M, Falconio G, Harris A. Reproducibility of nerve fiber layer thickness measurements using optical coherence tomography in silicone oil-filled eyes. Ophthalmologica. 2001;215:91-6.
6. Gabriele ML, Wollstein G, Ishikawa H, Kagemann L, Xu J, Folio LS, *et al*. Optical coherence tomography: history, current status, and laboratory work. Invest Ophthalmol Vis Sci. 2011;52:2425-36.
7. Piao CH, Kondo M, Tanikawa A, Terasaki H, Miyake Y. Multifocal electroretinogram in occult macular dystrophy. Invest Ophthalmol Vis Sci. 2000;41:513-7.
8. Kim JH, Kim YM, Chung EJ, Lee SY, Koh HJ. Structural and functional predictors of visual outcome of epiretinal membrane surgery. Am J Ophthalmol. 2012;153:103-10.
9. Dalan D, Jaishankar D, Madhu A, Mani K, Ratra D. Macular function assessment by multifocal electroretinogram and microperimetry in macular hole and correlation with visual acuity. Nepal J Ophthalmol. 2020;12:7-16.
10. Rashad MA, Mohamed AA, Ahmed AI. Value of optical coherence tomography in the detection of macular pathology before the removal of silicone oil. Clin Ophthalmol. 2016;10:121-35.
11. Petermeier K, Szurman P, Bartz-Schmidt UK, Gekeler F. [Pathophysiology of cataract formation after vitrectomy]. Klin Monbl Augenheilkd. 2010;227:175-80.
12. Deiss M, Kaya C, Pfister IB, Garweg JG. Impact of Vitreal Tamponade on Functional Outcomes in Vitrectomy with ILM Peeling in Primary Macula-Involving Retinal Detachment: A Retrospective Analysis. Clin Ophthalmol. 2020;14:4493-500.
13. Mangouritsas G, Mourtzoukos S, Portaliou DM, Georgopoulos VI, Dimopoulou A, Feretis E, *et al*. Glaucoma associated with the management of rhegmatogenous retinal detachment. Clin Ophthalmol. 2013;7:727-34.
14. Biswas J, Verma A, Davda MD, Ahuja S, Pushparaj V. Intraocular tissue migration of silicone oil after silicone oil tamponade: A histopathological study of enucleated silicone oil-filled eyes. Indian J Ophthalmol. 2008;56:425-8.
15. Issa R, Xia T, Zarbin MA, Bhagat N. Silicone oil removal: post-operative complications. Eye (Lond).

2020;34:537-43.
16. Muscat S, Parks S, Kemp E, Keating D. Repeatability and reproducibility of macular thickness measurements with the Humphrey OCT system. Invest Ophthalmol Vis Sci. 2002;43:490-5.
17. Nagpal MP, Videkar RP, Nagpal KM. Factors having implications on re-retinal detachments after silicone oil removal. Indian J Ophthalmol. 2012;60:517-20.
18. Martínez-Castillo V, Boixadera A, Distéfano L, Zapata M, García-Arumí J. Epiretinal membrane after pars plana vitrectomy for primary pseudophakic or aphakic rhegmatogenous retinal detachment: incidence and outcomes. Retina. 2012;32:1350-5.
19. Williams PD, Fuller CG, Scott IU, Fuller DG, Flynn HW. Vision loss associated with the use and removal of intraocular silicone oil. Clin Ophthalmol. 2008;2:955-9.
20. Ayaz Y, Öcal O, Erkan Pota Ç, Çetinkaya E, Erol MK, Ünal M, *et al*. Changes in retinal vessel and retinal layer thickness after cross-linking in keratoconus via swept-source OCT angiography. Graefes Arch Clin Exp Ophthalmol. 2022;260:3919-25.
21. Azarmina M, Soheilian M, Azarmina H, Hosseini B. Electroretinogram Changes following Silicone Oil Removal. J Ophthalmic Vis Res. 2011;6:109-13.
22. Boquete L, López-Guillén E, Vilades E, Miguel-Jiménez JM, Pablo LE, De Santiago L, *et al*. Diagnostic ability of multifocal electroretinogram in early multiple sclerosis using a new signal analysis method. PLoS One. 2019;14:e0224500.
23. Hood DC, Odel JG, Chen CS, Winn BJ. The multifocal electroretinogram. J Neuroophthalmol. 2003;23:225-35.
24. Foerster MH, Esser J, Laqua H. Silicone oil and its influence on electrophysiologic findings. Am J Ophthalmol. 1985;99:201-6.
25. Mitsch C, Pemp B, Pollreisz A, Gleiss A, Karst S, Scholda C, *et al*. Short-time effect of intravitreal injections on retinal vascular oxygenation and vessel diameter in patients with diabetic macular oedema or neovascular age-related macular degeneration. Acta Ophthalmol. 2020;98:e301-e8.
26. Lee SH, Han JW, Byeon SH, Kim SS, Koh HJ, Lee SC, *et al*. Retinal layer segmentation after silicone oil or gas tamponade for macula-on retinal detachment using optical coherence tomography. Retina. 2018;38:310-9.
27. Lou B, Yuan Z, He L, Lin L, Gao Q, Lin X, *et al*. The Changes of Retinal Saturation after Long-Term Tamponade with Silicone Oil. Biomed Res Int. 2015;2015:713828.
28. Gonvers M, Hornung JP, de Courten C. The effect of liquid silicone on the rabbit retina. Histologic and ultrastructural study. Arch Ophthalmol. 1986;104:1057-62.

How to Cite This Article
Massoud OM, El-Dessouky ESE, Serag YR, Enin MAAE. Correlation of macular optical coherence tomography pattern and visual recovery after vitrectomy with silicone oil for retinal detachment. International Journal of Medical Ophthalmology. 2023;5(2):113-121.