

Innovative Treatment for Glaucoma: Iridocorneal Angle in Phacovitrectomy with Silicone

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Abstract. Purpose: Evaluate the iridocorneal angle and anterior chamber depth (ACD) changes in eyes that underwent phacoemulsification surgery and in eyes that underwent phaco-vitrectomy with silicon oil as vitreous tamponade, and to compare results in both groups. **Methods:** We included a total of 30 eyes, of which 15 eyes underwent phacoemulsification surgery and 15 eyes phaco-vitrectomy procedure using silicon oil as vitreous tamponade. Iridocorneal angle and anterior segment depth postoperative changes were documented by using anterior segment Ocular Coherent Tomography (VISANTE-OCT). Basal images were taken and repeated 1 and 3 months after surgery. **Results:** We found in all cases a significant iridocorneal angle and anterior segment depth increase after surgery. However, those changes were not significant when comparing both groups. **Conclusions:** The use of silicon oil as vitreous tamponade does not modify the iridocorneal angle and anterior chamber depth.

Keywords: Ophthalmology, Glaucoma, Phacovitrectomy, logic gates, biorheology

1. Introduction

One of postoperative complications after vitrectomy is the temporary or permanent increase in 'intraocular pressure' (IOP). This increase is believed to be secondary to different factors such as the use of vitreous tamponades (gas or silicone oil), the inflammatory reaction, the use of corticosteroids, or rubeosis iridis of the iridocorneal angle.

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This paper evaluates the iridocorneal angle and anterior chamber depth (ACD) changes in eyes that underwent phacoemulsification surgery and in eyes that underwent phaco-vitreotomy with silicon oil as vitreous tamponade, and to compare results in both groups. Conclusions are then drawn from the analysis of the results.

2. Background and Contextualization

The pathophysiology of the temporary or permanent increase in IOP after the use of vitreous tamponades may be due to various circumstances. In case of using gas as endotamponade, the envelope of the same expansion generates an ocular hypertension in the immediate postoperative period, which can get to be importantly raised, requiring management of emergency for its control [1] – [3].

In case of using silicone oil (SO) as endotamponade, the increase in IOP may appear in the immediate postoperative period or later. This increase is due to the trabecular blockage by the presence of SO in the anterior chamber as a result of the migration of the SO of the vitreous cavity to the anterior chamber as a result of a pupillary blockade. The latter is usually caused by the lack of the inferior iridectomy, especially in patients with aphakia or pseudophakia, and can appear at any stage of the postoperative period. On the other hand, the retarded increase in IOP caused by SO can be induced in two ways, namely, (i) by migration of SO to the anterior chamber by its displacement due to the vitreous hemorrhages, detachment of the retina, or proliferative vitreoretinopathy, or (ii) by trabecular blocking produced by emulsified silicone oil (SO), especially in younger patients or those with high myopia [4] – [6].

Several studies by different authors [1] – [9] have demonstrated the increase (in degrees) of the iridocorneal angle, as well as the increase (in millimeters) of the depth of the anterior chamber (ACD) in patients undergoing surgery of phacoemulsification with implantation of the intraocular lens in the capsular bag [7] – [9].

The aim of this paper is to measure changes in the iridocorneal angle by means of the anterior segment optical coherence tomography (VISANTE). It will help us in verifying whether there occurs a narrowing of the same angle, which would justify the theory suggesting that an increase in the PIO is caused by the mechanical trabecular blocking induced by the higher density of the silicone oil.

3. Material and Method

It is a non-interventional, observational, prospective, and comparative experimental study. Included are a total of 30 patients, where 15 were only undergoing cataract phacoemulsification with implantation of an intraocular lens in the capsular bag (PHACO), and the remaining 15 eyes underwent combined surgery of phacoemulsification with implantation of the intraocular lens in the capsular bag plus the pars plana vitrectomy (PPV) with silicone oil as a tamponade (PHVSIL). We included patients (men and women) with an average age of 65.8 years (43-80).

We assessed the changes that occurred in the anterior chamber with the scanner's optical coherence of the anterior segment of (VISANTE, Carl Zeiss Meditec Inc.). The images were analyzed by the MATLAB software version 7.0. The parameters taken into account were: the nasal angle, the temporal angle, and the anterior chamber depth (ACD). Intakes and measures were carried out before and after the procedure in both groups; the post-treatment intakes were carried out in the period which spanned between the 1 month and 3 months after the operation.

The statistical analysis used a paired *T*-test and a single sample *T*-test applied to each group (PHACO and PHVSIL) comparing the pre-operational and post-operational data, as well as *T*-tests to compare both groups' post-operational data among them. In the analysis, it was considered that a *p*-value below 0.05 is statistically significant.

4. Results

The tests included a total of 30 eyes, the 15 of which were operated by phacoemulsification and the remaining 15 were treated by phacovitrectomy with the use of silicone oil. The average age of the patients was 65.8 years (between 43 and 80 years old).

Having analyzed the pre-operational data of the patients operated with a simple phacoemulsification, we detected that the average of the nasal iridocorneal angles was 24.79 grades, the average of their temporal angle was 25.36 grades, and the depth of the anterior chamber was on average 2.48 mm. After the operation, the following data were obtained: the average of the nasal angle became 39.96 grades, i.e., increased by 15.17 grades; the temporal angle reached 40.12 grades, that is, the average increment proved to be 14.76 grades; and finally, the depth of the anterior chamber extended up to 3.29 mm, that is, the average increase was 0.81 mm. The latter results demonstrate that a significant increase in these three parameters has been achieved (with the *p*-value lower than 0.005 for the Repeated Measures One-Samples *t*-test, Paired-samples *t*-test, and Pearson Correlation Coefficient test: see Tables 1-2).

Table 1. One sample *t*-test table.

PHACOEMUSIFICATION	N	Mean	St.Dev.	St.Err.Me an	<i>t</i> =	<i>p</i> <
PRE-IA NASAL	15	24.793	12.906	3.332	4.753	0.005
POST-IA NASAL	15	39.963	3.861	0.997	4.753	0.005
PRE-IA TEMPORAL	15	25.360	12.564	3.244	2.847	0.005
POST-IA TEMPORAL	15	40.124	3.664	0.946	2.847	0.005
PRE-ACD	15	2.486	0.389	0.100	8.153	0.005
POST-ACD	15	3.297	0.196	0.050	8.153	0.005

Table 2. Paired t-test table.

PHACOEMUSIFICATION	N	Mean	St.Dev.	St.Err.Me an	Corr.	t_{corr}	$p <$
PRE-IA NASAL	15	24.793	12.906	3.332	0.203	4.552	0.005
POST-IA NASAL	15	39.963	3.861	0.997	0.203	4.552	0.005
PRE-IA TEMPORAL	15	25.360	12.564	3.244	-0.025	4.551	0.005
POST-IA TEMPORAL	15	40.124	3.664	0.946	-0.025	4.551	0.005
PRE-ACD	15	2.486	0.389	0.100	0.205	8.075	0.005
POST-ACD	15	3.297	0.196	0.050	0.205	8.075	0.005

Similar results were obtained for the patients treated by phacovitrectomy. Namely, we detected that the pre-operation average of the nasal iridocorneal angles was 25.99 grades, the average of their temporal angle was 26.71 grades, and the depth of the anterior chamber was on average 2.50 mm. The post-operation data were as follows: the average of the nasal angle became 39.82 grades, i.e., it increased by 13.87 grades; the temporal angle reached 42.68 grades, that is, the average increment occurred to be 15.97 grades; and finally, the depth of the anterior chamber (ACD) extended up to 3.28 mm, that is, the average increase was 0.78 mm. The latter results show that again, a significant increase in these three parameters has been demonstrated (with the p -value below 0.005 for the Repeated Measures One-Samples t -test, Paired-samples t -test and Pearson Correlation Coefficient test: see Tables 3-4).

Table 3. One sample t-test table.

PHACOVITRECTOMY	N	Mean	St.Dev.	St.Err.Me an	$t =$	$p <$
PRE-IA NASAL	15	25.990	9.918	2.561	4.521	0.005
POST-IA NASAL	15	39.823	6.278	1.621	4.521	0.005
PRE-IA TEMPORAL	15	26.710	9.237	2.385	3.663	0.005
POST-IA TEMPORAL	15	42.686	11.281	2.912	3.663	0.005
PRE-ACD	15	2.503	0.328	0.084	8.511	0.005
POST-ACD	15	3.280	0.185	0.047	8.511	0.005

Table 4. Paired t-test table.

PHACOVITRECTOMY	N	Mean	St.Dev.	St.Err.Me an	Corr.	t_{corr}	$p <$
PRE-IA NASAL	15	25.990	9.918	2.561	-0.096	5.402	0.005
POST-IA NASAL	15	39.823	6.278	1.621	-0.096	5.402	0.005
PRE-IA TEMPORAL	15	26.710	9.237	2.385	-0.365	5.485	0.005
POST-IA TEMPORAL	15	42.686	11.281	2.912	-0.365	5.485	0.005
PRE-ACD	15	2.503	0.328	0.084	0.074	9.175	0.005
POST-ACD	15	3.280	0.185	0.047	0.074	9.175	0.005

On the other hand, having compared the post-operation results for both groups, no statistically significant difference was encountered in the data obtained by measuring the iridocorneal angle, the temporal angle, as well as the anterior chamber depth (ACD) for the patients treated with the two different modes (namely, the p -value turned out to be higher than 0.25 for the Repeated Measures One-Samples t -test, 0.18 for the Paired-samples t -test, and the Pearson Correlation Coefficient test: see Tables 5-6).

Table 5. One sample t-test table.

SIMPLE PHACOEMUL. VS. PHACOVITRECTOMY	N	Mean	St.Dev.	St.Err.Me an	$t =$	$p >$
NASAL IA PHACOEMUL	15	39.963	3.861	0.997	-0.104	0.28
NASAL IA PHACOVIT	15	39.823	6.278	1.621	-0.104	0.28
TEMP. IA PHACOEMUL	15	40.124	3.664	0.946	1.183	0.25
TEMP. IA PHACOVIT	15	42.686	11.281	2.912	1.183	0.25
ACD PHACOEMUL	15	3.297	0.196	0.050	-0.356	0.73
ACD PHACOVIT	15	3.280	0.185	0.047	-0.356	0.73

Table 6. Paired t-test table.

SIMPLE PHACOEMUL. VS. PHACOVITRECTOMY	N	Mean	St.Dev.	St.Err.Me an	Corr.	$t_{corr} =$	$p >$
NASAL IA PHACOEMUL	15	39.963	3.861	0.997	0.245	1.319	0.20
NASAL IA PHACOVIT	15	39.823	6.278	1.621	0.245	1.319	0.20
TEMP. IA PHACOEMUL	15	40.124	3.664	0.946	0.133	1.414	0.18
TEMP. IA PHACOVIT	15	42.686	11.281	2.912	0.133	1.414	0.18
ACD PHACOEMUL	15	3.297	0.196	0.050	-0.026	-0.580	0.57
ACD PHACOVIT	15	3.280	0.185	0.047	-0.026	-0.580	0.57

5. Results group Phacoemulsification

The results that were found in the group who only underwent phacoemulsification were as follows:

1. Increase of the nose angle is 61.19%
2. Increase in temporary angle is 58.22%
3. Increasing the depth of the anterior camera is 32.62%

6. Results group Phacovitrectomy

The results were found in the Group of Phacovitrectomy were the following:

1. Increase of the nose angle is 53.22%.
2. Increase in the temporary angle is 59.81%
3. Increase in the depth of the anterior Chamber is 30.24%.

7. Discussion

Previously published papers demonstrate that there is a statistically significant increase in both nasal and temporal iridocorneal angles and the depth of the anterior chamber (ACD) in patients operated for the cataract by phacoemulsification with implantation of the intraocular lens in the capsular bag. However there are no studies that quantify the iridocorneal angle and the depth of the anterior chamber in patients who were operated of phacoemulsification combined with implantation of the intraocular lens in the capsular bag plus the pars plana vitrectomy (PPV) with a silicone oil tamponade.

Our study demonstrates that there is a statistically significant increase in nasal, temporary angle and the Anterior Chamber Depth (ACD) after phacoemulsification cataract surgery.

In more detail, contrary to the null hypothesis, our results prove that there is also a statistically significant increase in the nasal angle, temporary angle and the depth of the anterior chamber in the group of patients who underwent the combined surgery. On the other hand, the changes in the temporal and nasal angles, as well as the depth of the anterior chamber (ACD) when a comparison between the two groups (*i.e.*, the simple PHACO, in the first group, and PHACO + PPV +SO, in the second group) is conducted, are statistically insignificant.

8. Conclusions

Our study demonstrates that the use of the tamponade with silicone oil in the vitreous cavity in patients operated by phacoemulsification with

implantation of an intraocular lens in the capsular bag combined with the pars plana vitrectomy (PPV) with tamponade with silicone oil:

- does not reduce (or narrow) the iridocorneal angle,
- does not reduce the depth of the anterior chamber (ACD).

We therefore exclude that the secondary intraocular hypertension detected in some post-surgical patients using this technique is due to a compressive mechanical blockade of the Maya trabecular caused by the higher density of the silicone oil.

9. Future work

In the context of biorheology silicone oil may be replaced by biorheological creams, gels, glues, slims or foams embedded with artificial wisdom intelligent entity logic gates. This would enable incubation within the host as bio-self-selecting systems, that is a likely to indicate in advance changes in the iridocorneal angle through the (VISANTE) anterior segment optical coherence tomography to assess whether there is a narrowing [10]. An intervention or countermeasures may then be used via the incubated artificial wisdom intelligent biorheological self-selecting systems.

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