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Influence of Silicone Oil Tamponade after Vitrectomy on Intraocular Pressure

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Abstract

Background: Glaucoma is a complicated disease in which damage to the optic nerve leads to progressive, irreversible vision loss. Glaucoma is the second leading cause of blindness.

Aim of Study: The aim of this study is to determine the possible influence of the silicone oil tamponade after vitrectomy on the intraocular pressure which is a major risk factor for developing secondary glaucoma and the effect of starting with anti-glaucoma therapy during the first 6 months post-operative.

Patients and Methods: This prospective study was conducted from February 2018 to August 2018 and involved 35 patients (25 patients with retinal detachment, 10 patients with advanced proliferative diabetic retinopathy). All patients had vitrectomy with silicone oil tamponade. All patients signed an informed consent to participate in the study.

Results: Early elevation of IOP is equally present in the patients with RD as well as in those with PDR. However, a qualitative analysis of the two groups of patients showed higher IOP in patients with PDR. Silicone oil significantly affect visual acuity in both groups of patients causing deterioration of the visual acuity which affect PDR group more than RD group.

Conclusion: Silicone oil as a tamponade agent after pars plana vitrectomy may cause rise in the IOP values in the early post-operative period in some patients. Therefore the timely detection and appropriate antiglaucoma treatment is extremely important since every elevation of the IOP may interfere with the positive outcome of the surgical procedure and functional visual outcome.

Key Words: *Silicone oil tamponade – Vitrectomy – Intraocular pressure.*

Introduction

GLAUCOMA is a complicated disease in which damage to the optic nerve leads to progressive, irreversible vision loss. Glaucoma is the second leading cause of blindness **[1]**.

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Risk factor for glaucoma include increased IOP greater than 21mmHg, family history, high blood pressure and obesity **[1]**. However some may have high IOP for years and never develop damage **[2]**. Conversely, optic nerve damage may occur with normal pressure, known as normal tension glaucoma **[3]**.

There are several different types of glaucoma, including open angle glaucoma and acute angle closure glaucoma. The treatment of glaucoma may include medication, surgery or laser surgery **[3]**.

Vitrectomy is an operation to remove the vitreous gel from the eye. Common indications include retinal detachment, vitreous hemorrhage, macular hole and intraocular foreign body **[4]**.

Silicone oil is a synthetic polymer made of repetitive (Si-O units) and is chemically similar to silicone rubber, except that silicone oil polymer chains are not cross-linked and are shorter than those of silicone rubber **[5]**. Silicone oil was first introduced by Cibis in 1962 for vitreoretinal surgery **[6]**.

Today silicone oil is an important adjunct for internal tamponade in a wide variety of vitreoretinal surgeries. Silicone oil instilled in the vitreous cavity ensures stability of the eye ball, restores the initial intraocular anatomical relations and slows down further proliferation, it is well tolerated and because of its transparency it enables easier post-operative visualization of the posterior segment **[7,8]**. Apart from the possible development of band keratopathy and Corneal decompensation one of the major side effects of the silicone oil is secondary IOP elevation **[9,10]**.

Secondary glaucoma can occur at any time in the post-operative period and may range from mild

and transient to severe and sustained IOP spikes, resulting in loss of vision [11].

Mechanisms responsible for developing secondary glaucoma are pupillary block [12], emulsified silicone oil bubbles in the chamber angle [13], angle closure by anterior synechial, inflammation, rubeosis iridis and idiopathic IOP rise after silicone oil instillation. The majority of these cases are well controlled by topical anti-glaucoma therapy, whereas the minority of patients require evacuation of the silicone oil to normalize IOP and the most refractory cases mandate penetrating filtration surgery in order to stabilize the IOP in the long term [14].

Aim of the work:

The aim of this study is to determine the possible influence of the silicone oil tamponade after vitrectomy on the intraocular pressure which is a major risk factor for developing secondary glaucoma and the effect of starting with anti-glaucoma therapy during the first 6 months post-operative.

Patients and Methods

This prospective study was conducted at Ain Shams University Hospitals from February 2018 to February 2019 on patients who were operated for rhegmatogenous RD and proliferative diabetic retinopathy (vitreous hemmorrhage). All patients had vitrectomy 23 gauge with silicone oil (1000 cs) tamponade. All patients signed an informed consent to participate in the study.

Study inclusion criteria:

- Patients of age 30-70 years.
- Patients have PPV with SOI.

Study exclusion criteria:

- Age less than 30 and more than 70 years.
- Patients with corneal decompensation.
- Cataract.
- Uveitis.
- Significant complication of surgery.
- Previous history of glaucoma and RD surgery in the same eye.

All patients underwent:

- Medical history for having any chronic disease (e.g., Hypertension (HTN), Diabetes Mellitus (DM), etc.).
- Ocular history taking for any chronic eye condition, previous ocular surgery (e.g., glaucoma, vitrectomy. etc.), past history of eye trauma, retinal detachment, vitreous or retinal hemorrhage and positive family history of glaucoma or other eye disease.

All patients had complete ophthalmologic examination which included:

- Assessment of visual acuity using auto chart projector (ACP-8) (Made in Japan).
- Examination of anterior segment using slit lamp biomicroscopy TOPCON (SL-3C) (Made in Japan).
- IOP measurement with applanation tonometry HAAG-STREIT (AT 900®). Swiss made.
- Gonioscopy was performed.
- Posterior segment examination with indirect ophthalmoscope using 20D lenses and with slit lamp using VOLK non-contact +90 lens (Made in Japan).
- B scan done before surgery.

Statistical analysis:

Data were analyzed using Statistical Program for Social Science (SPSS) 12 statistical package. Probability (p-value): p-value <0.05 was considered significant, p-value <0.001 was considered as highly significant, p-value >0.05 was considered insignificant.

Results

In our study 35 patients of age range from 32 to 67 years, 12 female and 23 male, there was right eye involvement in 17 cases and left eye involvement in 18 cases, 10 with PDR and 25 with RD, 23 were phakic and 12 were pseudophakic underwent pars plana vitrectomy (23 gauge) with silicone oil injection (1000cs).

The mean pre-operative IOP was 15.40mmHg with SD ±3.34 (range: 9 to 22mmHg). The mean post-operative IOP in the first day after PPV was 18.20mmHg with SD ±3.40 (range: 10 to 24 mmHg). The mean post-operative IOP after one week of surgery was 18.63mmHg with SD ±4.60 (range: 9 to 27mmHg). The mean post-operative IOP after two weeks of surgery was 20.69mmHg with SD ±8.94 (range: 8 to 49mmHg). The mean post-operative IOP after one month of surgery was 17.36 mmHg with SD ±4.92 (range: 8 to 30mmHg). The mean post-operative IOP after two months of surgery was 17.13mmHg with SD ±4.75 (range: 10 to 34mmHg). The mean post-operative IOP after six months of surgery was 16.60mmHg with SD ±3.30 (range: 8 to 24mmHg).

Table (1): IOP pre and post-operative.

IOP	No.=35	Mean ± SD or differences	*t*-test	*p*
Pre-operative:				
Mean ± SD	15.40±3.34	–	–	–
Range	9-22			
First day:				
Mean ± SD	18.20±3.40	2.80±3.20	5.181	0.000
Range	10-24			
First week:				
Mean ± SD	18.63±4.60	3.23±4.65	4.110	0.000
Range	9-27			
Second week:				
Mean ± SD	20.69±8.94	5.29±8.89	3.516	0.001
Range	8-49			
First month:				
Mean ± SD	17.36±4.92	2.00±5.15	2.229	0.033
Range	8-30			
Second month:				
Mean ± SD	17.13±4.75	1.97±4.87	2.213	0.035
Range	10-34			
Six months:				
Mean ± SD	16.60±3.30	1.43±4.04	1.943	0.062
Range	8-24			

p-value >0.05: Non significant (NS).
p-value <0.05: Significant (S).
p-value <0.01: Highly Significant (HS).
•: Paired *t*-test.

Table (2): LogMAR visual acuity pre and post-operative.

Log MAR visual acuity	No.=35	Mean ± SD or differences	*t*-test	*p*
Pre-operative:				
Mean ± SD	1.25±0.49	–		
Range	0-2			
First day:				
Mean ± SD	1.26±0.35	0.01±0.41	0.164	0.871
Range	0.1-2			
First week:				
Mean ± SD	1.19±0.35	–0.07±0.44	–0.892	0.379
Range	0.1-2			
Second week:				
Mean ± SD	1.14±0.32	–0.11±0.39	–1.712	0.096
Range	0.1-2			
First month:				
Mean ± SD	0.97±0.37	–0.27±0.38	–4.079	0.000
Range	0-1.8			
Second month:				
Mean ± SD	0.93±0.38	–0.25±0.35	–3.889	0.001
Range	0-1.8			
Six months:				
Mean ± SD	0.94±0.40	–0.24±0.37	–3.534	0.001
Range	0-1.8			

p-value >0.05: Non significant (NS).
p-value <0.05: Significant (S).
p-value <0.01: Highly Significant (HS).
•: Paired *t*-test.

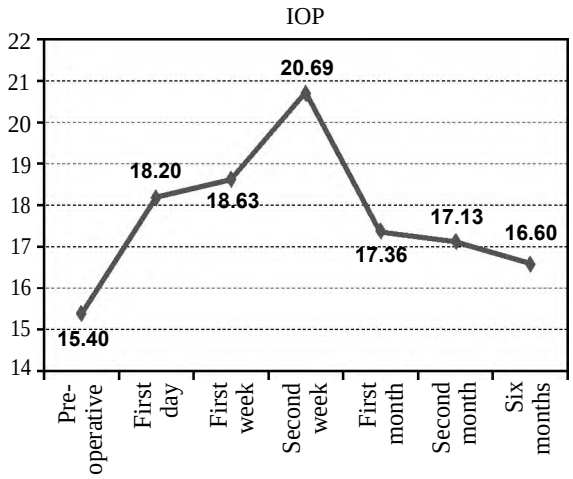

Fig. (1): IOP pre and post-operative.

The mean pre-operative vision was 1.25 with SD ±0.49 (range: 0 to 2). The mean postoperative vision in the first day after surgery was 1.26 with SD ±0.35 (range: 0.1 to 2). The mean post-operative vision after one week of surgery was 1.19 with SD ±0.35 (range: 0.1 to 2). The mean post-operative vision after two weeks of surgery was 1.14 with SD ±0.32 (range: 0.1 to 2). The mean post-operative vision after one month of surgery was 0.97 with SD ±0.37 (range: 0 to 1.8). The mean post-operative vision after two months of surgery was 0.93 with SD ±0.38 (range: 0 to 1.8). The mean post-operative vision after six months of surgery was 0.94 with SD ±0.40 (range: 0 to 1.8).

Table (3): Comparison between RD and PDR regarding IOP.

IOP	RD	PDR	Test value•	*p*-value	Sig.
Pre-operative:					
Mean ± SD	14.40±3.07	17.90±2.73	–3.140	0.004	HS
Range	9-20	13-22			
First day:					
Mean ± SD	17.76±3.54	19.30±2.91	–1.218	0.232	NS
Range	10-24	15-23			
First week:					
Mean ± SD	18.72±5.07	18.40±3.37	0.183	0.856	NS
Range	9-27	14-24			
Second week:					
Mean ± SD	20.04±8.14	22.30±11.02	–0.670	0.508	NS
Range	8-40	14-49			
First month:					
Mean ± SD	16.13±4.73	20.67±3.97	–2.556	0.016	S
Range	8-27	17-30			
Second month:					
Mean ± SD	16.18±4.86	19.75±3.45	–1.901	0.068	NS
Range	10-34	17-28			
Six months:					
Mean ± SD	15.77±3.12	18.88±2.80	–2.472	0.020	S
Range	8-20	14-24			

p-value >0.05: Non significant (NS).
p-value <0.05: Significant (S).
p-value <0.01: Highly Significant (HS). •: Independent *t*-test.

This table showing comparison between RD and PDR patients regarding IOP. Mean IOP in PDR patients pre-operative was 17.90mmHg ±2.73 while in RD patients was 14.40mmHg ±3.07 (p-value 0.004). Mean IOP in PDR patients first day post-operative was 19.30mmHg ±2.91 while in RD patients was 17.76mmHg ±3.54. Mean IOP in PDR patients one week post-operative was 18.40mmHg ±3.37 while in RD patients was 18.72mmHg ±5.07. Mean IOP in PDR patients two weeks post-operative was 22.30mmHg ±11.02 while in RD patients was 20.04mmHg ±8.14. Mean IOP in PDR patients one month post-operative was 20.67mmHg ±3.97 while in RD patients was 16.13mmHg ±4.73 (p-value 0.016). Mean IOP in PDR patients two months post-operative was 19.75mmHg ±3.45 while in RD patients was 16.18mmHg ±4.86. Mean IOP in PDR patients six months post-operative was 18.88mmHg ±2.80 while in RD patients was 15.77mmHg ±3.12 (p-value 0.020). This showing that there was clinically significant difference in IOP between two groups after one month and six months post-operative. The results showing that the early elevation of the IOP, measured two weeks after vitrectomy, is equally present in the patients with retinal detachment as well as in patients with diabetic retinopathy. However, the analysis of the two groups of patients showed higher IOP elevation in the diabetic retinopathy group.

Table (4): Comparison between pre and post-operative IOP in patients needed medical treatment.

	Mean	SD	F*	p-value
Pre-operative	15.87	3.18	5.31	<0.001
First day	20.13	2.19		
One week	21.06	4.55		
Two weeks	25.81	10.87		
Four weeks	18.87	5.56		
Eight weeks	18.37	5.73		
Twenty four weeks	17.00	3.12		

*: Repeated measure ANOVA.

This table show the mean IOP with SD for 16 patients, who had increase in IOP and need medical treatment describing that after two weeks of PPV with silicone oil injection the mean IOP 25.81 with SD 10.87mmHG and need medical treatment with antiglaucoma drugs which continued along the period of the study (6 months).

Discussion

Silicone oil as a tamponade agent after pars plana vitrectomy in the early post-operative period may cause IOP elevation in some patients. Patients at risk of developing secondary glaucoma after silicone oil tamponade are diabetics, aphakic patients and those with pre-existing glaucoma. Mechanisms responsible for developing secondary glaucoma are pupillary block due to the obstruction of peripheral iridectomy [12], emulsified silicone oil bubbles in the chamber angle [13], angle closure by anterior synechial, inflammation, rubeosis iridis, idiopathic IOP rise after silicone oil instillation as well as the surgeon's inattention and overfilling of the eye with silicone oil. The most of these cases are well controlled by topical antiglaucoma therapy, whereas the minority of patients require evacuation of the silicone oil to normalize IOP and the most refractory cases mandate penetrating filtration surgery in order to stabilize the IOP in the long term [14].

First observations of IOP elevations associated with silicone tamponade date back to the time when silicone oil was used as an instrument. In 1967, Watzke was first to record an increase in IOP upon intraocular silicone oil injection [15].

In our study 35 patients of age range from 32 to 67 years, 12 female and 23 male, there was right eye involvement in 17 cases and left eye involvement in 18 cases, 10 with PDR and 25 with RD, 23 were phakic and 12 were pseudophakic underwent pars plana vitrectomy (23 gauge) with silicone oil injection (1000cs). Intraocular pressures were measured before surgery, then at one day, one week, two weeks, 1 month, two months and six months after surgery. The mean pre-operative IOP 15.40±3.34mmHg (range 9.00-22.00mmHg). First day post-operative mean IOP 18.20 ±3.40mmHg (range 10.00-24.00mmHg, p<0.000). One week post-operative mean IOP 18.63±4.60mmHg (range 9.00-27.00mmHg, p 0.000). Two weeks post-operative mean IOP 20.69 ±8.94mmHg (range 8-49.00mmHg, p 0.001).

This showing that there is clinical significant difference in IOP pre-operative and after one day, one week, two weeks post-operative with silicone oil tamponade. One month post-operative mean IOP 17.36±4.92mmHg (range 8-30mmHg). Two months post-operative mean IOP 17.13±4.75mmHg (range 10.00-34.00mmHg). Six months post-operative mean IOP 16.60±3.30mmHg (range 8.00 to 24.00mmHg). In this study the peak elevation of IOP after pars pana vitrecomy with silicone oil tamponade was two weeks after surgery mean IOP 20.69±8.94mmHg (range 8-49.00mmHg, p 0.001). An increase in IOP developed in 45.7% of the patients (16 eyes) in the post-operative period (two weeks) with mean IOP 25.81 ±10.87mmHg (range 28.00-49.00mmHg).

Our results suggest that the early elevation of IOP is equally present in the patients with RD as well as in those with PDR. However, a qualitative analysis of the two groups of patients showed higher IOP in patients with PDR. There was non-significant difference in IOP between phakic and pseudophakic groups.

Silicone oil significantly affect visual acuity in both groups of patients at one month, second month and six months post-operative causing mild improvement of the visual acuity with nonsignificant difference between PDR and RD groups or phakic and pseudophakic groups.

All of these patients required medical treatment with antiglaucoma medications. No patients in this series had uncontrolled IOP.

Other results Popovic et al., **[16]** showed that mean values of IOP measured at one month after surgery significantly exceed the preoperative values in patients with post-vitrectomy silicone oil tamponade. Their mean IOP values measured at one month after surgery were also higher than those recorded at that same time in patients with postvitrectomy air or saline tamponade. The IOP measurements at 6 and 12 months after surgery, when silicone oil was removed from patients' eyes, showed that mean IOP values are similar in two groups of patients and do not differ much from the initial, pre-operative values.

Gonioscopy was used to assess the potential effect of silicone oil tamponade on the morphology of the anterior segment of the eye, especially the angle of the anterior chamber. In some patients, the effects of silicone oil tamponade on the anterior segment morphology were the narrowing of the angle and the development of adhesions between the iris and anterior chamber angle structures.

In another prospective study Suzana et al., **[17]** The results suggest that the early elevation of the IOP, measured one month after vitrectomy, is equally present in the patients with retinal detachment as well as in patients with diabetic retinopathy. However, a qualitative analysis of the two groups of patients showed higher IOP elevation in the early post-operative period in the diabetic retinopathy group. The higher IOP values in this group of patients one month after vitrectomy are to a certain extent related with the basic pathological process, diabetes, which owing to retinal ischemia causes neovascularization of the chamber angle, present in 10% of patients and it may also cause a secondary glaucoma. Although we did not found statistically significant difference in the angle width before and after vitrectomy among the observed groups, the finding of the emulsified silicone oil in 18% of patients with retinal detachment and 17% in diabetic retinopathy group may suggest its possible influence on the early elevation of the IOP values.

Other study Mohammad et al., **[18]** show that the mean IOP was raised in the immediate postoperative period (day 1); thereafter the levels declined after one month and six months, but remained steady at three months. Following silicone oil removal, the mean IOP showed a significant drop to normal levels in 24 (80%) cases but remained at slightly raised levels in the remaining 6 (20%) cases. Regression analysis showed a highly significant correlation between the pre and post silicone oil removal IOP values.

There is difference between our results and the previous results where increase of IOP started one month post-operative. This difference may be due to different methods of follow-up where in our study the follow-up was one day, one week, two weeks, one month, two months and six months post-operative, while in almost of the previous studies the follow-up starting one month post-operative.

Conclusion:

Silicone oil as a tamponade agent after pars plana vitrectomy may cause rise in the IOP values in the early post-operative period in some patients. Therefore the timely detection and appropriate ant glaucomatous treatment is extremely important since every elevation of the IOP may interfere with the positive outcome of the surgical procedure and functional visual outcome. The IOP elevation in the early post-operative course in these challenging patients presents a major risk factor for developing a secondary glaucoma.

The study showing that there is clinically significant difference in IOP pre-operative and after one day, one week, two weeks post-operative with silicone oil tamponade. Peak value of IOP was at two weeks after surgery in 53.3% of patients who need medical treatment with antiglaucoma medications. The early elevation of IOP is equally present in the patients with RD as well as in those with PDR. However, a qualitative analysis of the two groups of patients showed higher IOP in patients with PDR. Silicone oil significantly affect visual acuity in both groups of patients causing deterioration of the visual acuity with more affection in PDR group, so we recommend the early follow-up of IOP post-operative and early treatment

of elevated IOP with topical antiglaucoma medication.

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تآثير زيت السيليكون بعد إستئصال الجسم الزجاجى على ضغط العين

الخلفية: الجلوكوما مرض معقد يؤدى فيه تلف العصب البصرى إلى فقدان رؤية تدريجى لا رجعه فيه. الجلوكوما هو السبب الرئيسى الثانى للعمى.

الهدف من الدراسة: الهدف من هذه الدراسة هو تحديد التآثير المحتمل زيت السيليكون بعد إستئصال الزجاجية على الضغط داخل العين وهو عامل خطر رئيسى لتطوير الجلوكوما الثانوية وتآثير البدء فى العلاج المضاد للجلوكوما خلال ٦ آشهر بعد العملية الجراحية.

المرضى والطرق: آجريت هذه الدراسة المرتقبة من فبراير ٢٠١٨ إلى آغسطس ٢٠١٨ وشارك فيها ٣٥ مريضاً (٢٥ مريضاً يعانون من إنفصال الشبكية، ١٠ مرضى يعانون من إعتلال الشبكية السكرى المتقدم). خضع جميع المرضى إستئصال الجسم الزجاجى مع حقن زيت السيليكون. وقع جميع المرضى على موافقة مستنيرة للمشاركة فى هذه الدراسة.

النتائج: الإرتفاع المبكر لضغط العين موجود على قدم المساواة فى المرضى الذين يعانون من إنفصال شبكى وكذلك فى المرضى الذين يعانون من إعتلال الشبكية السكرى المتقدم ومع ذلك، آظهر التحليل النوعى لمجموعتى المرضى نتائج آعلى لضغط العين فى المرضى الذين يعانون من إعتلال الشبكية السكرى المتقدم. يؤثر زيت السيليكون بشكل كبير على حدة البصر فى كلتا المجموعتين من المرضى مما يتسبب فى تحسن حدة البصر فى كلتا المجموعتين.

الخلاصة: يمكن آن يسبب زيت السيليكون بعد إستئصال الجسم الزجاجى إرتفاعاً فى قيم ضغط العين فى فترة ما بعد الجراحة لدى بعض المرضى. لذلك فإن الإكتشاف المبكر لإرتفاع ضغط العين وإستخدام العلاج المضاد للجلوكوما آمر مهم للغاية لآن كل إرتفاع فى ضغط العين قد يتداخل مع النتيجة الإيجابية للعملية الجراحية والنتائج البصرية الوظيفية.