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Research Article

Visual Outcomes after Silicone Oil Removal in Jordan

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Abstract

Background: Sutureless vitrectomy is considered as one of the most popular pars plana vitrectomy as it includes minimal invasive procedure. Silicone oil is referred as a liquid, which possesses unique properties related to surface tension. This liquid is considered to be widely utilized as an internal tamponading agent during diversified ophthalmological surgical procedures, specifically for the retinal attachment surgery.

Methodology: Procedures related to the removal of silicone oil might increase the risk of retinal detachment along with other severe complications. This research was carried out in three eye centers in Jordan that analyzed and compared visual outcomes of two different types of silicone oils having different viscosities (1000 cs and 5000 cs). The procedure proceeded after removal of silicon oil from eyes with stabilized retina after the completion of vitreoretinal procedures for retinal detachment.

Results: Potential complications associated with silicone oil removal might be dependent on diversified factors, including viscosities of silicone oil, time elapsed between pars plana vitrectomy, and need for silicone oil removal. Research outcomes demonstrated that re-detachment rates associated to 5000 cs silicone oil were higher as compared to 1000 cs silicone group.

Conclusion: The results concluded that poor functional as well as anatomic outcomes were found to be strongly associated with the utilization of high viscosity silicone oil (5000 cs) as compared to low viscosity silicone oil (1000 cs).

Keywords: *Silicone; Retinal Detachment; Viscosity; Vitrectomy*

Introduction

Sutureless vitrectomy is considered as one of the most popular pars plana vitrectomy. It is included among some of the surgeries, which involve minimally invasive surgical procedure [1]. In the light of recent research, this treatment might also be considered as a more feasible treatment to carrying out compared with the conventional 20-guage vitrectomy for Rhegmatogenous Retinal Detachment (RRD) [2]. Moreover, other reasons behind the utilization of sutureless vitrectomy are the provision of faster rehabilitation, enhanced levels of comfort experienced by patient, and less conjunctival fibrosis [3].

Silicone oil is referred as a liquid, which possesses unique properties related to surface tension [4]. This liquid is considered to be widely utilized as an internal tamponading agent during diversified ophthalmological surgical procedures, specifically for the retinal attachment surgery. It might also serve as a toxic for the photoreceptors, despite the efficiency and wide utilization of silicone oil [4]. The long-term adverse impacts of silicone oil might also cause serious complications including secondary glaucoma, cataract, and keratopathy [5]. Therefore, the removal of silicone oil is most often considered as essential in a wide majority of ophthalmological surgeries.

The occurrence of silicone oil related complications had enhanced the tendency of oil removal after a particular period of filling. There are no differences in the tamponading forces, which are affected by silicone oils of different viscosities [6]. The penetration depth, opti-

cal transmittance, and absorption spectra of mid-infrared cutting lasers through the silicon oils of different viscosities are found to be identical. Moreover, it is also argued that silicone oil having low viscosity is anticipated to undergo earlier emulsification [7]. Therefore, potential side effects related to the utilization of lower viscosity silicon oil enhance the risk of side effects including, glaucoma, cataract, and keratopathy [8].

The etiology of endophthalmitis after undergoing the sutureless vitrectomy is associated with the postoperative hypotony, which enhances the risk of admission of bacteria from the ocular surface. The unresponsiveness of endophthalmitis might be considered as an indication for evisceration [9]. However, an earlier increment in the intraocular pressure might also be considered as one of the most common silicone oil related complications [10]. This complication is most often resulted due to hemorrhage, utilization of viscoelastic materials, and the silicone oil tamponade [11]. The elevation of intraocular pressure as long-term impact of vitrectomy is still considered as a controversial issue [11]. Therefore, it is imperative to select silicone oil having most suitable viscosity and to remove silicone oil after acquiring stabilized retinal attachment [12].

This research will analyze and compare visual outcomes of two different types of silicone oils, having different viscosities (1000 cs and 5000 cs) after removal in eyes with stabilized retina.

Methods

This research has recruited 100 patients (one eye in each patient), who underwent silicone oil removal during the years 2013 - 2015 at three eye centers in Jordan. This research was conducted after acquiring approval from Ethics Committee in Faculty of Medicine-Mutah University (20176). All the recruited research participants' experienced different degrees of emulsification prior undergoing silicone oil removal, such as the early appearance of fish egg like structure in the superior retina. In a similar manner, the droplets of oil which could only be appreciated by slit lamp was also included in the degrees of emulsification. Data related to age, gender, the indication of pars plana vitrectomy, time elapsed between pars plana vitrectomy and silicone oil removal, and the need for silicone oil removal was collected before recruiting patients. It was ensured that eyes of research participants were relatively stable before removing silicone oil.

31 eyes were filled with 1000 cs silicone oil, whereas, rest of the 69 eyes were filled with 5000 cs. The volume of injected silicone oil ranged from 3.5 cc to 4.5 cc. The participants underwent ophthalmological procedures including; slit lamp examination, best-corrected visual acuity test, applanation tonometry, gonioscopy, indirect ophthalmoscopy before and after undergoing the procedure of silicon oil removal. Review of patients' charts was conducted for analyzing the pre-clinical status of the silicone oil, status of the retina including the status of macular area, the cause of retinal detachment, types of retinal breaks in traumatic eye injuries, and the grading of proliferative vitreoretinopathy.

The recruited research participants were aphakic, phakic, or pseudophakic; therefore, different methods were used for silicone oil removal. An infusion cannula, which was connected to an infusion bottle was placed through the inferior temporal pars plana into the mid vitreous cavity. As silicone is light in weight, and possess the ability to float in water, which assists infusion fluid to flow inside the eyes. The silicone oil was expelled through the superior limbal incision in aphakic eyes. No other membrane was removed; however, small intraocular silicone bubbles were found to remain postoperatively in most of the aphakic cases. Limbal incision and the sclerotomy were closed, which was followed by the re-approximation of conjunctiva. For phakic and pseudophakic patients, two port system were established after the sclerotomies. These ports were approximately at the distance of 3.5 mm from limbus. Both ports were located at the superonasal and inferotemporal quadrants which were utilized for the removal of silicone oil. These procedures were followed by subconjunctival injection of steroids and antibiotics.

Patients' data was statistically analyzed by utilizing SPSS software. The measured outcomes include the rates of retinal redetachment, final visual acuity and the rates of final intraocular pressure after the removal of silicon oil.

Results

52 of the participants were males and 48 were females. Mean age of research participants considered in this research was 58.33 years. Minimum age of research participants was 45 years; whereas, the maximum age of research participants was 82 years. 41 of the operated eyes were right; whereas, rest of eyes were left. The research participants experienced a variety of silicone oil related complications including:

- **Raised Intraocular Pressure:** Out of 100 research participants, 42 of them were found to have raised intraocular pressure after the pars plana vitrectomy. On the contrary, the rest of 58 research participants did not demonstrate any sort of increment in the intraocular pressure.
- **Changes in Refractive Index:** All the participants were found to experience changes in their refractive status.
- **Band Keratopathy:** Out of 100 research participants, 8% of them developed band keratopathy in follow-up period.
- **Silicone oil Emulsification:** 15% of the participants had only silicone oil emulsification by follow-up period.
- **Proliferative Vitreoretinopathy (PVR):** Out of 100 research participants, 41 research participants were suffering from complex retinal detachment associated with the PVR. The extent of retinal detachment was ranged from three to four quadrants. The PVR grade C was observed in almost all cases. The anterior PVR was present in all eyes and also involved six clock hours in 15 eyes. Moreover, posterior PVR was appreciated in 26 eyes, involving 6 to 12 clock hours. On the contrary, six eyes possessed multiple large peripheral breaks.

Among individuals present in the endophthalmitis group, there were six cases due to the post-traumatic bacterial endophthalmitis, two cases of post-cataract surgery bacterial infections, and two cases of the bleb-associated endophthalmitis were observed.

Every surgical indication was found in approximately equal proportions of the 1000 and 5000 cs oil categories. All patients who had experienced pars plana vitrectomy and then silicone oil removal were found to possess stable retina prior to undergoing the surgical procedure for at least the period of 90 days.

After pars plana vitrectomy, mean time of oil removal was 9 ± 4.5 months for those eyes, which were filled with silicone oil having viscosity of 1000 cs. On the contrary, mean time for oil removal for eyes filled with 5000 cs silicone oil was 13 ± 6.5 months (Table 1).

	Silicone 1000 cs		Silicone 5000 cs	
	No	**%**	**No**	**%**
< 5 months	13	41.93	15	21.73
5 - 10 months	14	45.16	21	30.43
10 - 20 months	4	12.90	30	43.47
> 20 months	0	0	3	4.34
Total	31	100	69	100

Table 1: *The duration of retention of silicone oil before its removal.*

The retinal detachment of research participants was resolved by utilizing pars plana vitrectomy; therefore, all eyes had stable retina before silicone oil removal. The retinal attachment was ensured in approximately 72% of the cases after silicone oil removal; whereas, recurrent retinal detachment was observed in 28% of the individuals. Re-detachment of retina was found in approximately 5 patients (16.13%), out of 31 eyes filled with 1000 cs silicone oil. On the contrary, it was found in 23 (33.33%) out of 69 eyes were filled with the silicone oil having viscosity of 5000 cs. The statistical analysis revealed that this difference was found as statistically significant (P = 0.007). The rate of re-detachment for eyes with PVR was higher (34.1%). Considering this particular context, the rates of redetachment after silicone oil removal, in eyes filled with 1000cs and 5000cs silicone oil were found to be 18.2% and 40%, respectively (P = 0.0003). After the removal of silicone oil, eyes filled with 5000 cs silicone oil were at an increased risk of re-detachment, as compared to the eyes filled with 1000cs silicone oil (relative risk was 4.28%).

Visual acuity was improved in approximately 42 (42%) eyes after the removal of silicone oil. Visual acuity was improved among 13 patients (41.93%) recruited in 1000 cs group. On the contrary, visual acuity among 29 eyes (42%) was improved in 5000 cs group. After pars plana vitrectomy, the visual acuity of counting finger was observed in 48.39% cases associated to 1000 cs silicone oil and approximately 57.97% cases with 5000 cs silicone oil. On the contrary, after the completion of silicone oil removal, visual acuity of counting fingers was observed in 32.26% and 46.38% cases for 1000 cs and 5000 cs silicone oils, respectively.

While, conducting the multivariate analysis, visual acuity of 6/120 or less than this value was utilized as an outcome. The visual acuity of 6/120 or less was dependent on initial visual acuity and viscosity of silicon oil. Visual acuity among patients having initial values of visual acuity 6/120 or less remained similar or further decrease after the removal of silicone oil. It was also found that patients who were provided with 5000cs silicone oil were also at less chance of improving visual acuity.

After pars plana vitrectomy, 42 out of 100 research participants had developed increased intraocular pressure, which was > 21 mmHg. After the surgical procedure of silicone oil removal, the intraocular pressure remained high in 11 eyes; however, in the remaining 89 eyes, the intraocular pressure was found within or lower than normal range (21 mmHg > Intraocular pressure > 5 mmHg). 4% of the individuals were found to suffer from severe levels of hypotony, such that intraocular pressure was ≤ 4 mmHg). With the exclusion of those eyes, which experienced re-detachment of the retina after the removal of silicone oil. 85% of the participants still possessed intraocular pressure within normal ranges.

After the completion of silicone oil removal procedure, the intraocular pressure ≥ 21 mmHg was considered as an outcome in a regression model. The intraocular pressure was only influenced by the anatomic status of retina. In this regard, those eyes, which experienced re-detachment of retina after silicon oil removal possessed an average of 7.73 mm Hg lower IOP as compared to individuals having attached retina.

Discussion

The utilization of silicone oil in treating complex retinal detachment has been considered to have beneficial impacts; however, there are diversified complications associated with silicone oil usage. The silicone oil of different viscosities has similar tamponading effects prior to the emulsification of oil. In this non-randomized research, the study has analyzed the outcomes of surgical procedures for the treatment of retinal detachment, which was followed by the removal of silicone oil of two different viscosities, 1000 cs, and 5000 cs, respectively. In this regard, prior to the removal of silicone oil, it was ensured that eyes of all research participants had stable and attached retina. In this study, silicon oil emulsification was found in 15 eyes up to some degree. Therefore, the tamponading force of the silicone oil was lost prior to the removal of silicone oil in these cases. The overall re-detachment rate in this research was almost 28%. A wide majority of the retinal redetachment was observed within 3 months after the removal of oil. The rates of re-detachment in eyes associated with proliferative vitreoretinopathy exceeded the rates in other potential complications. The re-detachment rates associated with the 5000 cs silicone oil was higher as compared to 1000 cs silicone group. The fundamental cause behind the recurrent retinal detachment following the removal of silicone oil was associated with proliferative vitreoretinopathy, which caused re-opening of the existing retinal breaks.

Other common post-operative complications included keratopathy, glaucoma, cataract, increment in the intraocular pressure, and endophthalmitis [13]. The utilization of silicone oil, following the procedure of vitrectomy might be considered as an appropriate approach because it assists in reducing complications. The extent of complications related to the silicone oil might also be dependent on the time elapsed between surgical procedure and silicone oil removal. In a similar manner, there are no definitive indications emphasizing on the silicone oil removal. On the contrary, the rate of attachment and re-detachment of retina after silicone oil removal also vary for one complication to another. The reported incidence related to the incidence of re-detachment varies from one patient to another. This variation is most often due to the durations of follow-up after the removal of silicone oil and the nature of complication associated with silicone oil removal. Moreover, the effectiveness of silicone oil removal along with suppression in the levels of complications is also dependent on the

viscosities of silicone oil [14]. After the intervention of vitrectomy techniques, silicone oil is widely considered as retinal tamponade and vitreous substitute [15]. The silicone oil is also recognized as a useful tool for treating complex retinal detachments; however, the demonstration related to the most appropriate viscosity of silicone oil is still unanswered. A study has demonstrated that the tamponading forces of silicone oils of diversified viscosities are similar. In this regard, the most frequently utilized silicone oil is purified polydimethylsiloxanes. The viscosities of polydimethylsiloxanes range from 100 cs to 12500 cs [12]. A wide majority of vitreoretinal surgeries are carried out by utilizing silicone oils having viscosities of 1000 cs and 5000 cs; therefore, these two viscosities were specifically considered for this research.

Silicone oils having low viscosity are preferred by some of the surgeons, because the surgical handling and removal of low viscosity silicone oil, could be accomplished by utilizing an easier approach. On the contrary, silicone oils having high viscosity levels cause delayed and decreased emulsification [16]. This intentional delay in emulsification assist in boosting the effects of tamponading forces; therefore, utilization of high viscosity silicone oils is considered appropriate even for most complex forms of retinal detachments. Similar to other complication, endophthalmitis might be also considered as one of the most significant silicone oil usage indications. The fundamental reason behind this complication relates to the closure of wound in sutureless para plana surgical procedures [17]. For severe endophthalmitis, vitrectomy combined with the silicone oil tamponade might be considered as effective treatment strategy for endophthalmitis. Vitrectomy might also assist in treating increased intraocular pressure. Moreover, the retinal detachment is also considered as one of the most serve complication of endophthalmitis [18].

Conclusion

The occurrence of silicone oil related complications has enhanced the tendency of oil removal after a particular period of filling. The percentage of retinal redetachment has been significantly increasing due to diversified complications associated to the removal of silicone oil. The results have concluded that poor functional as well as anatomic outcome were found to be strongly associated with the utilization of high viscosity silicone oil (5000 cs) as compared to the low viscosity silicone oil (1000 cs). The validity of observations must be reconfirmed by randomized controlled trial in future due to potential limitations associated with the retrospective studies. The accomplishment of stabilized and re-attached retina is the first priority of all retinal surgeries. The possibility of achieving this objective might be enhanced by utilizing the silicone oil of high viscosity for longer period.

Conflict of Interest

The authors declare no conflict of interest.

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