Conventional Silicone Oil for Retinal Detachment with Inferior Breaks

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Abstract

Aim: To report the long term results of pars plana vitrectomy (PPV) for rhegmatogenous retinal detachment (RRD) with conventional silicone oil in the presence of inferior retinal breaks and to compare the results with published data of heavy silicone oil.

Design: Retrospective interventional case series study.

Method: Forty four consecutive eyes of 43 patients presenting with RRD and inferior breaks were enrolled in this study. Our inclusion criteria included eyes with large, multiple and/or irregular inferior breaks (4 to 8 O’clock), giant retinal tears with large inferior component and eyes with inferior retinotomies (180º or more). Cases presenting with macular hole detachments, diabetic tractional detachments or combined tractional/rhegmatogenous retinal detachments were all excluded from our study. All patients were operated by PPV techniques and 1000cs silicone oil tamponade. No scleral buckling was performed in any of the included eyes.

Results: Intraoperative anatomical reattachment was achieved in all 44 eyes. Recurrent retinal detachment before silicone oil removal occurred in 10 eyes, of which; reoperation was performed on 7 eyes and retina was successfully reattached in 5 eyes bringing our success rate to 39/44 eyes (88.6%). After oil removal recurrence occurred in 5 eyes; a redo was performed and retinal reattachment was achieved in 4 eyes. Final success rate was achieved in 38/44 eyes (86.4%) with 4 eyes retaining their silicone oil.

Conclusion: The results of this study suggest that conventional silicone oil is an effective tamponade in cases of RRD associated with inferior breaks. Our results are comparable to those of heavy silicone oil with the advantage of less complications and easier manipulation of conventional silicone oil as compared to heavy silicone oil. It is therefore questionable whether there is any need to abandon conventional silicone oil in eyes with RRD associated with inferior breaks or retinotomy.

Key Words: Pars plana vitrectomy (PPV) – Rhegmatogenous retinal detachment (RRD) – Inferior breaks – Silicone oil.

Introduction

TREATMENT of complex cases of retinal detachments using internal tamponade agents produces successful anatomical success with restoration of vision in many cases; however, recurrence rates for RRD could be as high as 10% to 20% and even higher in the presence of PVR [1].

Internal tamponade agents act in a number of ways in retinal reattachment surgery. They occlude retinal breaks by virtue of their surface properties, preventing recruitment of sub-retinal fluid from the vitreous cavity; their buoyancy pushes the retina towards the pigment epithelium; volume displacement opposes redetachment and may exclude the inflammatory milieu of the aqueous phase from the re-attached retina [2].

The effectiveness of a tamponade agent is influenced by the properties of the material and the way in which it interacts with the retina and the remaining aqueous [3]. On the short term; this is controlled by the agent’s specific gravity and interfacial tensions. On the long term; this is controlled by the agent’s viscosity, which is critical in maintaining its integrity and thus reducing its dispersion. In case of gas or air; the difference in specific gravity between it and water is great, therefore, a large bubble has a flat bottom. This flattening of the bubble increases the tamponade efficiency in that more of the volume contributes towards making contact with the retina [4]. In case of silicone oil; the specific gravity (0.97g/cm³) is close to that of water (1.0g/cm³), therefore, a large bubble has a rounded bottom because there is little buoyancy to modify its shape. The overall tamponade efficiency is decreased because part of the volume is used to form the meniscus instead of making contact with the retina [5]. This difference in efficiency between silicone oil and gas is inherent in their physical properties in terms of surface energy and specific gravity and cannot be modified.
except perhaps by strategies such as posturing or the use of surgical explants [6].

The absence of effective tamponade is understood to allow the accumulation in the "empty space" of fluids, cellular and molecular elements responsible for PVR and RRD recurrences. The two main classical endotamponading agents (gas and silicone oil), because of their density lighter than intraocular fluid, are often grouped together as agents that do not tamponade the inferior quadrants. However, both physical properties and clinical experience suggest that gases and silicone oil are not very similar as tamponading agents for the inferior retina [7].

Several heavier-than-water endotamponade agents have been suggested aiming at eliminating the inferior empty space and thus providing a better tamponade for inferior retina. During the 1990s fluorinated silicone oil, which has a specific gravity higher than that of water, was used as an alternative internal tamponade, but its use was discontinued due to the high frequency of complications [8-9]. Perfluorocarbon liquids (PFCLs) have been increasingly used as tools in vitreoretinal surgery, and their use suggested the idea of also using these substances as heavy tamponades [10-11]. However, it has been demonstrated that PFCLs are not well tolerated as long-term internal tamponades, due to their potential retinal toxicity [12]. Eventually, semi-fluorinated alkanes (FALKs), perfluorohexyloctane (F6H8), have been proposed as a heavy long-term tamponade. Although they seem to be better tolerated in the eye, their use is complicated by their frequent emulsification and small-bubble dispersion [13-14]. For all these reasons, the use of silicone oil in combination with FALKs (heavy silicone oil [HSO]) has been suggested [15,16].

Interest in combining two substances with different specific gravities to develop a vitreous substitute that is transparent, stable, homogeneous and if possible effective over the whole retina is increasing. Eventually, studies concerning Densiron-68 (a solution of F6H8 and 5,000 mPas silicone oil) [17] and Oxane HD (a solution of 5,700 mPas silicone oil and RM3) [18] have been reported.

This study is aimed at evaluating the efficacy of conventional silicone oil as a long acting tamponade for managing cases presenting with RRD associated with inferior retinal tears and to compare our results with other studies that have evaluated the role of HSO in managing these cases.

**Patients and Methods**

Forty four consecutive eyes of forty three patients, presenting with RRD and inferior retinal breaks, were enrolled in this retrospective interventional case series study in the period between January-2004 till June-2007. Inclusion criteria included 13 eyes with large, multiple and/or irregular inferior breaks (4 to 8 O’clock), 8 eyes with giant retinal tears with large inferior component (2 of these 8 eyes were complicated by PVR) and 23 eyes with inferior retinotomies (180° or more). Cases presenting with macular hole detachments, diabetic tractional detachments or combined tractional/rhegmatogenous retinal detachments were all excluded from this study.

Preoperative evaluation included slit-lamp biomicroscopy fundus examination and peripheral retinal evaluation with the binocular indirect ophthalmoscope. The number, type (operculated or horseshoe tear), position (anterior to the equator, equatorial and posterior to the equator), and size of breaks were determined preoperatively. During postoperative follow-up, the relationship between the silicone bubble and retinal breaks was established by slit-lamp biomicroscopy.

Three-port PPV was performed using a wide-angle viewing system. Complete central and peripheral vitreous was done. Triamcinolone acetonide was used to assist peeling of posterior hyaloid whenever needed. All epiretinal membranes were peeled and removed. Subretinal membranes were removed when judged to interfere with retinal reattachment. The vitreous base was shaved in all eyes aided by 360° deep scleral depression. Retinotomy was done when felt necessary to overcome retinal shortening or undissectable membranes. In cases with giant retinal tears and/or retinotomy, the anterior retinal flap was excised up to the ora serrata. Retinal reattachment was achieved by injecting PFCL over the posterior pole, through a 20-gauge canula. Once PFCL reached the posterior border of the break, fluid/air exchange was performed to drain the intraocular fluid anterior to the retinal break(s) or retinotomy. Silicone oil 1000cs was then injected via the infusion canula to replace the air anterior to the break and then the PFCL posteriorly. This was followed by application of two or three rows of endolaser retinopexy (523nm, frequency doubled diode laser, IRIS Medical Inc.) to secure the causative breaks. At the end of the procedure, the sclerotomies were carefully reviewed before closure.
Post-operatively, patients were not instructed to take any particular position after surgery. Patients were followed-up at one day, one week, one month, three months and six months postoperatively. All patients completed the follow-up period; visual acuity, anatomic reattachment and PVR rate were examined at each visit.

**Results**

A total of 44 eyes of 43 patients were included in this study. These were twenty eight males and 16 females. Follow-up period was for a minimum of 6 months for all cases. Mean patient age was 54.6 years (range, 32-74 years). At baseline, 12 patients were phakic and the remaining 32 patients were pseudophakic with a PC-IOL.

On baseline examination, the macula was detached (macula off) in 40/44 eyes. No serious intraoperative complications did take place, apart from few iatrogenic breaks occurring in 9 patients, which were treated with laser retinopexy.

**Anatomical results:**

Retinal reattachment was achieved in all (44) eyes at the end of the first surgery. During the follow-up period, with silicone oil still in the vitreous cavity, 10 eyes had recurrent RRD (23%). Three of these 10 patients refused any further surgeries, so a redo was performed successfully on only 7 eyes with reapplication of conventional 1000cs silicone oil. During the follow-up period retinal reattachment was achieved in 5 of these 7 eyes bringing our success rate to 39/44 eyes (88.6%). After oil removal 5 eyes developed recurrence and a redo was successfully performed with reapplication of conventional 1000cs silicone oil. During the follow-up period; the retina was successfully reattached in 4/5 eyes bringing our final success rate to 38/44 eyes (86.4%). Silicone oil was safely removed from only one eye and was retained in the other 4 eyes. Of the 4 eyes that retained silicone oil; 2 of them was due to chronic hypotony induced by generous retinotomies and the remaining 2 due to patients’ refusal.

![Fig. (1-A): A case of total RRD with 2 large inferior horseshoe tears & PVR.](image1)

![Fig. (1-B): A case of total RRD with an inferior giant tear & PVR.](image2)

![Fig. (2-A): Showing retinal reattachment after silicone oil removal for a case of inferior retinal tears & PVR.](image3)

![Fig. (2-B): Showing retinal reattachment after silicone oil removal for a case of giant tear; notice the retinectomy is scarred with complete lack of proliferation.](image4)
Functional results:

At baseline examination, the best corrected visual acuity (BCVA) values ranged from HM to 0.3 (6/24). At the end of our 6 month follow-up period; the BCVA remained unchanged in 7 eyes (15.9%) that presented with macula on RRD, improved in Twenty seven eyes (61.4%) and deteriorated in the remaining 10 eyes (22.7%).

Complications:

Twelve eyes were phakic at baseline examination; 10 of which had posterior subcapsular cataract formation during the follow-up period and therefore underwent cataract extraction (phacoemulsification with intraocular lens implant) at the time of tamponade removal. Four eyes did develop secondary glaucoma during our follow-up period that was controlled medically with 2 eyes regaining normal IOP after oil removal. Only eight eyes developed silicone oil emulsification at the end of our follow-up period and oil was safely removed from the eight eyes. Finally, two eyes developed silicone oil keratopathy which was complicating total oil migration in the anterior segment.

Discussion

Inferior RD presents a distinctive surgical challenge to vitreoretinal surgeons. When with inferior breaks are managed by vitrectomy, a scleral buckling (SB) is often felt necessary in order to achieve adequate tamponade of the inferior retina especially if gas is used as a tamponade [19]. However, there has been an increasing trend to move away from SB owing to its complications, such as: choroidal haemorrhage, [20] diplopia, [21] extrusion, [22] infection, [22] and anterior segment ischaemia [23]. Silicone oil as a long-term internal tamponade agent, is well recognized as an effective agent for the treatment of RD complicating PVR and is currently used widely [24,25]. With the two conventional tamponades (gas and silicone oil) it is observed that recurrent RD is often inferior. This was understood to be mainly due to the lack of tamponading effect inferiorly owing to the specific physical properties of these agents and the related buoyancy [7].

Based on this concept, various attempts have been undertaken to develop a heavier-than-water vitreous substitute. The theoretical advantages of the higher specific gravity tamponades are the long-term retinal tamponade to the inferior quadrants and the possibility of the more comfortable supine positioning postoperatively as compared to the less comfortable face down positioning, often needed in case of gas tamponade [26]. Fluorinated silicone oil, [8-9] perfluorocarbon liquids (PFCL), [10-11] semi-fluorinated alkanes (FALKs) - perfluoro-hexyloctane (F6H8), [13-14] were introduced. However, they were all abandoned because of their high complication rates. Accordingly, the use of silicone oil in combination with FALKs (heavy silicone oil [HSO]) has been suggested [15-16]. Two types of HSO were introduced in market and gained popularity over the past decade; Densiron-68 (a solution of 5,000 mPas silicone oil and F6H8) [17] and Oxane HD (a solution of 5,700 mPas silicone oil and partially fluorinated olefin [RM3]) [18].

In our hands, conventional silicone oil has been the tamponade of choice in all cases of retinal detachment with any significant PVR; even when inferior breaks are present. In the series presented in this study, it is seen that after initial intraoperative retinal reattachment of all 44 eyes, 34 eyes remained attached and 10/44 eyes (23%) had recurrent RD over the inferior retinal quadrants complicating PVR. With additional surgery, the final success rate for full anatomical reattachment was 38/44 eyes (86.4%). This result is comparable to results of multiple studies with the use of heavy silicone oil. However, apart from recurrent PVR, the complication rate is much in favor of conventional silicone oil.

Multiple studies have been reported on the use of HSO for RD. Indications for the use of HSO includes PVR, RD with inferior breaks and inability to posture [27-28]. The reported anatomical success rates obtained with the various heavy agents that have been studied until now have varied (83%, [29] 86%, [30] and 94% [31]) depending on the different period of follow-up and the variable definition of anatomical success. Only Kirchhof et al. [29], Wong et al. [32] and Rizzo et al. [33] considered retinal reattachment successful without any endotamponade. Kirchhof et al. [29] had a success rate of 82% using perfluorohexyloctane filling. Wong et al. [32] reported an anatomical success rate of 81% with a single operation and 93% with further surgeries.

In our series, no significant emulsification occurred that would have reduced the efficacy of the oil tamponade as described for HSO. Only eight patients, in our study group, that showed mild silicone oil emulsification presenting with either media haze or mild anterior chamber emulsified oil droplets. On the other hand; reports on HSO emulsification are quite variable; Wong et al., reported in their study that heavy oil emulsification is low, with little or no clinical impact [34]. However, Sandner and Engelmann reported emulsification of Densiron in seven out of 48 patients.
with pseudo-hypopyon formation in four patients. For this reason, they routinely performed anterior chamber irrigation upon Densiron removal [35]. Emulsification with HSO is a problem, because when it does occur it leads to partitioning of heavy oils into their component parts and increases the likelihood of oil-related problems, such as inflammation, keratopathy and secondary glaucoma. In addition, separation of F6H8 may lead to retinal toxicity, further intraocular inflammation and subsequent ERM and CMO formation and this effect has clearly been shown [36].

Furthermore; no significant intraocular inflammation was noticed in any of our patients throughout the follow-up period. On the other hand, excessive granulomatous inflammation was observed in 37% of eyes in a case series reported by Theelen et al., of 19 eyes undergoing PPV and Oxane-HD tamponade for complicated RD [37], where the inflammatory response completely resolved after HSO removal. However; no postoperative inflammation exceeding that of routine vitreoretinal surgery was noticed by Wolf et al. [31], Rizzo et al. [38] and Cheung et al. [39], in which Oxane HD was found to be safe without adverse events including intraocular inflammation after tamponade of up to 3 months.

Probably the central question posed by this study is: how can we explain the efficacy of conventional silicone oil in these eyes despite the well known physical properties?

We believe that: 1) Tamponade is not a substitute for radical surgery. 2) Gas is different from silicone oil although both are lighter than water. 3) In case of well mobilized retina (free from membranes), there is no actual need of that "pressure" exerted by the tamponade. It is just enough to minimize the fluid currents thus allowing for the vitreoretinal pump; it is observed that the mobilized retina tends to reattach unless traction forces overcome and therefore absolute tear closure is not needed. An analogous situation to this is well recognized in the excellent results often achieved in cases of primary RD treated by scleral buckle with non drainage techniques. 4) Almost total silicone oil eye fill is recommended in eyes with inferior breaks. This is quite achievable technically either by drying up the fluid meniscus at the edges between the infused silicone oil coming from above and the PFCL bubble resting posteriorly before it is removed, or by leaving the eye normotensive at the end of surgery. An almost total fill is probably helpful in minimizing the fluid space between the retina and the oil bubble thus helping the RPE pump and reducing the space for cellular mediators of reproliferation.

To our knowledge, no clinical trial on the efficacy of standard silicone oil relative to HSO has been performed so far. In our case series study on the treatment of eyes with RRD complicated by PVR and inferior retinal tears, we did not find significant differences in functional and anatomical outcomes between our results by using 1000cs silicone oil and published results using HSO. Considering the additional advantages of conventional silicone oil, such as; ease of removal, less inflammation, less emulsification, possibility of extended use in certain situations and the longer test of time; it is questionable if HSO, at its present state, would really offer an advantage over conventional SO. Although we do recognize that conventional silicone oil has its inherent limitations as tamponade, we do not see the need to abandon it for HSO at the present state of knowledge and experience.

References


