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Long-term outcomes of heavy silicone oil tamponade for complicated retinal detachment

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PURPOSE. *To assess the long-term success rates and complications of heavy silicone oil tamponade (Oxane HD) in the management of complicated retinal detachment with proliferative vitreoretinopathy (PVR).*

METHODS. *Twenty-one eyes of 21 patients with complicated retinal detachment and PVR were included in this study. Vitreoretinal surgery with heavy silicone oil (Oxane HD) tamponade was performed in all patients. Heavy silicone oil was injected by perfluorocarbon liquid-air-silicone oil exchange, and was removed after 3 months. The main outcomes of the surgery including the success and complication rates were evaluated during the mean follow-up period of 11.4±0.88 months. Wilcoxon signed ranks test was used for statistical analysis of visual acuity changes. The outcomes of our study were compared with those of the previous studies.*

RESULTS. *All eyes had complicated retinal detachment with PVR Grade C3 or worse. Retinal detachment was rhegmatogenous in 6 eyes, secondary to previous detachment surgery in 11 eyes, secondary to proliferative diabetic retinopathy in 3 eyes, and secondary to perforating eye injury in 1 eye. The overall anatomic success rate was 80.9% at the end of the follow-up period. The overall visual success rate was 42.8%, with no statistically significant difference from baseline ($p>0.05$). Postoperative complications included severe reproliferation (4 eyes), intraocular pressure rise (3 eyes), anterior dislocation of silicone oil (2 eyes), posterior subcapsular cataract formation (4 eyes), vitreous hemorrhage (1 eye), rubeosis iridis (3 eyes), optic atrophy (1 eye), and ocular pain and photophobia (21 eyes).*

CONCLUSIONS. *According to the results of this study, vitreoretinal surgery with temporary heavy silicone oil tamponade appears to increase the anatomic success rates with minimal complication rate in cases with complicated retinal detachment and PVR. (Eur J Ophthalmol 2007; 17: 797-803)*

KEY WORDS. *Heavy silicone oil, Oxane HD, Proliferative vitreoretinopathy, Retinal detachment, Vitreoretinal surgery*

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INTRODUCTION

The surgical treatment of complicated retinal detachment with inferior retinal tears and proliferative vitreoretinopathy (PVR) is challenging. Silicone oil and long-acting intraocular gases, which are the most commonly used endotamponades in such cases, provide good support for the superior retina (1-3). However, due to their lower specific gravity than that of water, they leave a residual space in the inferior retina, and result in ineffective tamponade, ineffective closure of retinal breaks, and PVR development in that region (4-11).

PVR, which is characterized by the development of contractile membranes within the retinal layers, is the most common cause of failure in retinal detachment surgery (1-5, 7, 9, 12). Histopathologically, these contractile membranes are triggered by the retinal pigment epithelial cells (RPE), which scatter to the vitreous through the retinal

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tears, or during detachment surgery. In eyes with previous retinal surgery and silicone oil tamponade, PVR generally initiates in the inferior retina (5-9). In order to prevent PVR development, effective tamponade of the inferior retina without leaving any residual space and fluid is crucial (9-11). Therefore, heavy silicone oil, which has a higher specific gravity than that of water, has been introduced for the treatment of such cases with inferior retinal breaks and PVR (5, 7, 8, 10, 11).

In this prospective study, we aimed to evaluate the long-term anatomic and visual success rates and complications of heavy silicone oil in cases with complicated retinal detachment and PVR.

MATERIALS AND METHODS

This study prospectively enrolled 21 eyes of 21 patients with retinal detachment and associated PVR grade C3 or worse, who underwent vitreoretinal surgery with heavy silicone oil (Oxane HD) tamponade at Ankara Ulucanlar Eye Research Hospital. The study was conducted after obtaining informed consent from each patient, and was approved by the local ethical committee of our hospital. The mean follow-up period of the study was 11.4 ± 0.88 months (range, 10 to 12 months). Outcomes of the surgery, including the overall anatomic and visual success rates and the complications, were evaluated at the end of the follow-up period.

Before surgery, detailed ophthalmologic examinations including best-corrected visual acuity with Snellen charts, biomicroscopic anterior segment examination, dilated posterior segment examination, and intraocular pressure (IOP) measurements were performed. Eyes with total or subtotal retinal detachment due to various causes with PVR grade C3 or worse were included in the study, while eyes with PVR less than grade C3 were excluded.

Surgical technique

Patients older than18 years were operated under local retrobulbar anesthesia, while general anesthesia was performed in patients younger than 18 years. All eyes underwent standard three-port pars plana vitrectomy (PPV). In five eyes with lens opacification, lens extraction with clear corneal phacoemulsification without intraocular lens implantation was performed immediately before PPV. After complete removal of the vitreous and posterior hyaloid, epiretinal membranes were removed by the aid of triamcinolone acetonide or membrane blue. Triamcinolone acetonide was used in eyes with thin membranes due to its perfect accumulation on those membranes, while membrane blue was used in eyes with thicker membranes. Relaxing retinotomies, subretinal membrane excision, and subretinal fluid drainage were performed in required cases. Retinal attachment was achieved by using perfluorodecaline liquid. Retinal endolaser photocoagulation was performed to the inferior retinal quadrant and to the margins of retinal tears and retinotomies. In aphakic eyes with posterior capsular opening, peripheral iridectomy was performed to the 12 o'clock quadrant of the iris. After perfluorodecaline-air-heavy silicone oil exchange, operation was completed by the suturation of sclerotomies and the conjunctiva with 6-0 Vicryl.

After the operation, the patients received the routine postoperative regimen of our clinic including oral ciprofloxacin 250 mg twice daily for 2 weeks, oral indomethacin 75 mg once daily for 1 week, frequent instillations of topical prednisolone acetate 1% for 8 weeks, and topical fucidic acid twice daily for 1 month. All the patients were instructed to sleep in supine head position during the night in order to avoid silicone oil–lens contact.

Postoperative follow-up examinations were performed weekly for the first month, and monthly thereafter. Visual acuities, intraocular pressures, anterior chamber and fundus findings, and complications were recorded for each patient. Heavy silicone oil was removed with active aspiration at the third postoperative month. The procedure was performed with three-port pars plana approach using endoillumination and aspiration needle with a viscous fluid injection syringe in aspiration mode with a suction of up to 600 mmHg. Silicone tipped backflush needle was used to aspirate silicone remnants over the retinal surface.

Frequent postoperative follow-ups continued after silicone oil removal, and the overall success rate of the surgery was evaluated according to the retinal and visual findings at the final visit. Anatomic success was defined as complete retinal attachment in the absence of retinal traction, and without the need for further surgery. Visual success was defined as any quantitative visual improvement compared to the preoperative visual acuity. For statistical analysis, visual acuities were converted to equivalent Snellen values defined in the standardized visual acuity conversion chart. The preoperative and postoperative visual acuities were compared with Wilcoxon signed ranks test.

RESULTS

Of the 21 patients, 15 (71.4%) were male, and 6 (28.5%) were female. The mean age of the patients was 50.09±19.5 (range, 7 to 82) years. Total retinal detachment was present in 12 (57.1%) cases, and subtotal (inferior quadrant detachment) in 9 (42.8%) cases. The cause of retinal detachment was inferior retinal tear in 6 (28.5%) eyes, previous unsuccessful retinal surgery in 11 (52.3%) eyes, retinal traction secondary to proliferative diabetic retinopathy in 3 (14.2%) eyes, and perforating eye injury in 1 (4.7%) eye (Tab. I). The accompanying retinal pathologies were retinal tear in any quadrant in 16 eyes, giant retinal tear in the superior quadrant in 2 eyes, epiretinal membrane in 8 eyes, macular hole in 1 eye, vitreous hemorrhage in 2 eyes, and encirclement due to previous conventional detachment surgery in 6 eyes.

Retinal reattachment was achieved in all cases under silicone oil tamponade at the end of the first postoperative month; however, redetachment with severe PVR development occurred in the case with retinal detachment secondary to perforating eye injury, just before the removal of silicone oil. As no anatomic success was expected, we did not perform any further operations in that case.

During the follow-ups after the removal of silicone oil, retinal redetachment occurred in six other cases. Of these six cases, two with proliferative diabetic retinopathy developed iris neovascularization and severe PVR involving the entire retina, which was more prominent in the inferior quadrant. They did not accept reoperation since the hope of visual improvement was little. The remaining four cases with superior retinal detachment were reoperated with reinjection of Oxane HD, followed by its removal after 3 months. The final examinations after the second operation revealed surgical success in three of these cases; however, severe PVR development and vitreous hemorrhage occurred in one. At the end of the follow-up period, anatomic success was achieved in 17 cases (80.9%), 14 of them after single surgery, and 3 of them after the second surgery (Tab. II).

The preoperative visual acuity was light perception in 1 case, hand motions (0.001 Snellen lines) in 12 cases, and counting fingers (0.01 Snellen lines) in 8 cases, while the postoperative visual acuity at the final examination was hand motions in 9 cases, counting fingers in 10 cases, and 0.1 Snellen lines in 2 cases. The visual acuity increased in 9 cases, decreased in 4 cases, and remained unchanged in 8 cases. The mean preoperative visual acuity was 0.004±0.005, and the mean final postoperative visual acuity was 0.01±0.03. The overall visual success rate, defined as any quantitative increase in the Snellen visual acuity level, was recorded as 42.8%; however, the difference between preoperative and postoperative visual acuity levels did not attain statistical significance ($p>0.05$). We observed no intraoperative complications. Mild intraocular inflammation was present at the first postoperative day, which disappeared within the first week. The postoperative complications included temporary increase

TABLE I - CAUSES OF RETINAL DETACHMENTS (RD) IN 21 CASES BEFORE VITREORETINAL SURGERY WITH OXANE HD TAMPONADE

Cause	No. of eyes (%)
Rhegmatogenous RD	6 (28.5)
Previous retinal surgery	11 (52.3)
Tractional RD (PDR)	3 (14.2)
Traumatic RD (perforation)	1 (4.7)

PDR = Proliferative diabetic retinopathy

TABLE II - THE ANATOMIC SUCCESS RATES OF 21 CASES AFTER VITREORETINAL SURGERY WITH OXANE HD TAMPONADE

	No. (%) of eyes with anatomic success
After first vitreoretinal surgery	14 (66.6)
After second vitreoretinal surgery	3 (14.2)
Total	17 (80.9)

TABLE III - POSTOPERATIVE COMPLICATIONS IN 21 EYES WITH OXANE HD TAMPONADE

Complication	No. of eyes (%)
IOP increase	3 (14.2)
Silicone oil dislocation to anterior chamber	2 (9.5)
Cataract	4 (19)
Optic atrophy	1 (4.7)
Vitreous hemorrhage	1 (4.7)
Rubeosis iridis	3 (14.2)
Severe PVR	4 (19)
Ocular pain and photophobia	21 (100)

IOP = Intraocular pressure; PVR = Proliferative vitreoretinopathy

TABLE IV - THE PHYSICAL PROPERTIES OF STANDARD AND HEAVY SILICONE OIL

	Standard silicone oil	Oxane HD (Oxane 5700 and RMN3)	Densiron 68 (perfluorohexyloctane and 5000 cs silicone)
Density, g/cm3	0.98	1.03	1.06
Viscosity, mPa.s	1000–5000	3300	1387
Surface tension, Mn/m	36	>40	40.82

of IOP in three cases, silicone oil dislocation to the anterior chamber in two cases, cataract formation in four cases, vitreous hemorrhage in one case, rubeosis iridis in three cases, PVR development in four cases, optic atrophy in one case, and ocular pain and photophobia in all cases (Tab. III).

DISCUSSION

The introduction of endotamponades including silicone oil and long-acting intraocular gases increased the success rates of vitreoretinal surgery in cases with complicated retinal detachment (1-3). However, as they are lighter than water and float, those endotamponades fail to provide an effective support for the inferior retinal tears and inferior retinotomies. Moreover, as they insufficiently occupy the inferior vitreous cavity, a residual space is left in that region, where cellular proliferation and PVR development occurs. These limitations of standard silicone oil and gases led to the investigations for heavier-than-water endotamponades (5-11).

The first endotamponade suggested for effective tamponade of the inferior retina was perfluorocarbon liquid (perfluorodecalin, perfluorohexyloctane). However, since it causes trophic retinal changes and retinal toxicity, perfluorocarbon liquid is not recommended for postoperative tamponade (6-9).

In complicated retinal detachment, there is a propensity to PVR development, which frequently initiates in the inferior retina. Therefore, effective tamponade of the inferior retina with heavier-than-water endotamponades may be helpful for surgical success. In recent studies, successful results have been reported with heavy silicone oil endotamponades (Densiron 68, Oxane HD) in complicated cases with inferior retinal tears (5, 7, 8, 10, 11).

In this study, we used Oxane HD as long-acting endotamponade for the management of complicated cases. Oxane HD is a novel silicone oil which is a mixture of ultrapurified silicone oil (Oxane 5700, Bausch & Lomb) and RMN3, a partially fluorinated olefin. It has a higher density (1.03 g/cm^3) and surface tension (>40 Mn/m) than that of standard silicone oil (Tab. IV). Oxane HD is well-tolerated in the eye and does not cause any retinal toxicity up to 3 months. It provides a good support for the inferior retinal tears. It is also advantageous in patients who cannot tolerate postoperative prone head positioning (5, 7, 8, 11). Considering these advantages, Oxane HD was the choice of endotamponade in our cases with severe PVR.

The long-term anatomic success rate of our study was 80.9%. This result was obtained after single operation in 66.6% of the cases and after two operations in 14.2% of the cases. Superior retinal detachment was observed as a disadvantage of heavy silicone oil. Since Oxane HD ineffectively tamponaded the superior retina, redetachments usually initiated at this region. Similar results have been obtained in the study of Wolf et al, who reported a success rate of 82% and reoperation rate of 18% in their cases with Oxane HD tamponade (7). They have also reported the reason for reoperation as superior retinal detachment. In the study of Tognetto et al, the anatomic success rate by using a mixture (30% perfluorohexyloctane and 70% silicone oil 1000 cs) as a heavy internal tamponade has been reported as 92.3%, with 69.2% of them having a visual acuity better than 20/400, which was a better result than ours (11).

In the study of Rizzo et al, the overall anatomic success rate using Oxane HD has been reported as 53.5% (8). However, this rate has increased to 84.6%, when the cases with previous marked buckling have been excluded. They have suggested the reason for the failure in buckled eyes as the low affinity of Oxane HD to the retinal surface and its inability to adapt to the retinal surface changes caused by the indent. Its poor contact with the sides of buckling has been reported to cause residual space filled with fluid surrounding the indent, where reproliferation has

occurred. However, we found no relation between previous scleral buckling and postoperative PVR development in our cases. On the contrary, we observed that due to its low viscosity and high motility, Oxane HD easily surrounded the retinal surface. It also prevented postoperative traction due to epiretinal reproliferation. Hence we propose that Oxane HD successfully stabilizes the retina by acting as a barrier between the postoperative reproliferations and the retinal surface. Standard silicone oil tamponade, on the other hand, has been reported to cause epiretinal membrane proliferation between the retinal surface and posterior surface of silicone oil (13).

Several publications have reported the success rates of standard silicone oil and perfluoropropane gas (C_3F_8) tamponade in the management of complicated retinal detachment (1-3). Scott et al have achieved anatomic success in 80% of their cases with complex retinal detachment using standard silicone oil with 1000 or 5000 centistokes (1). In the report of the Silicone Study Group, outcomes of standard silicone oil tamponade in eyes with PVR grade C3 or worse have been compared with those of C_3F_8 tamponade. Reattachment rate has been reported as 64% using silicone oil, and 73% using C_3F_8, while no significant difference has been reported between those two tamponades (2). Blumenkranz et al have performed relaxing retinotomy using standard silicone oil or long-acting gas tamponade in eyes with severe PVR, and have reported higher retinal reattachment rate with silicone oil compared to C_3F_8 gas (54% vs 40%) (3). In our study, we achieved better anatomic outcomes using Oxane HD compared to those studies using standard silicone oil or long-acting gas tamponade.

Unlu et al have evaluated anatomic prognosis after standard silicone oil removal in eyes operated for complex retinal detachment, and have reported redetachment in 23.5% of the eyes with residual vitreoretinal traction in vitreous base. As a consequence they have suggested using staining dyes, such as trypan blue for more complete epiretinal membrane removal (4). We are in agreement with using staining dyes in epiretinal membrane removal; however, we would like to add that triamcinolone acetonide is also an important tool for membrane visualization and removal. According to our experience, triamcinolone acetonide accumulates better than membrane blue on thin membranes, while membrane blue is better absorbed by thick membranes.

In the report of the Silicone Study Group, comparable visual success rates have been reported with silicone oil and C_3F_8 tamponade (45% vs 43% for eyes without prior vitrectomy, and 33% vs 38% for eyes with prior vitrectomy) (2). Blumenkranz et al have also reported no significant difference between silicone oil and C_3F_8 gas tamponade regarding final visual success rates (42% vs 10%) (3). Comparable to those results, visual improvement was achieved in 42.8% of our cases using Oxane HD.

The common complications of heavy silicone oil were similar to but lower than those of standard silicone oil, which included IOP rise, dislocation of silicone oil to the anterior chamber, and cataract formation. Postoperative early IOP rise can occur due to a number of factors including pupillary block, excessive amount of silicone oil injection, increased episcleral venous pressure, obliteration of collector channels due to cauterization of sclerotomy places, and inflammation (16-19). Pupillary block, which is the most common reason for early postoperative IOP rise, can be prevented by performing peripheral iridectomy to the 12 o'clock quadrant in eyes with heavy silicone oil tamponade (7). In our cases the IOP rise was thought to be due to episcleral venous pressure rise and inflammation caused by silicone oil–ciliary body contact, as it was easily controlled by medical anti-inflammatory and antiglaucoma treatment. However, in cases with increased IOP due to mechanical factors such as excessive silicone oil injection, it cannot be decreased unless some amount of silicone oil is removed (17). In our study, we performed peripheral iridectomy only in aphakic eyes with posterior capsular opening, and we observed no pupillary block.

Heavy silicone oil dislocation to the anterior chamber occurred in two aphakic eyes. Silicone oil droplets were removed via anterior chamber irrigation without meeting any complications in the first day postoperatively. Heavy silicone oil in the anterior chamber should be surgically removed as soon as possible because it can cause significant corneal endothelial cell loss leading to corneal decompensation in a short time. Endothelial cell loss has been reported to be pronounced in aphakic eyes without a physical barrier between the anterior segment and the vitreous cavity, and in the case of oil migration into the anterior chamber (20). Besides the endothelial toxicity, the mechanical effect of heavy silicone oil in the anterior chamber may lead to iridocorneal contact resulting in peripheral anterior synechiae or iridolenticular posterior synechiae. Furthermore, because of its high surface tension, it cannot relocate to the posterior chamber by supine head positioning in aphakic patients.

Silicone oil causes cataract in up to 80% of phakic cases within 6 to 18 postoperative months, which is mainly due to its mechanical effect (14, 15). In our study, the rate of cataract development was found to be lower than the rates reported with standard silicone oil. This was thought to be mainly because of the supine head positioning after heavy silicone oil injection which prevented silicone oil–lens contact, and partly due to the short tamponade period of 3 months.

Besides these common complications, heavy silicone oil also has unique complications due to its physical properties. As a result of its high gravity, it applies mechanical pressure over the retina, and may cause retinal vascular occlusion, retinal hemorrhage, and optic atrophy (6, 7). In the study of Wolf et al, among 33 cases with Oxane HD tamponade, retinal hemorrhage has been recorded in two eyes and retinal arterial occlusion in one eye, which have regressed after silicone oil extraction. They have suggested the vascular complications to be a consequence of the mechanical effect of Oxane HD (7). In our study, we observed no vascular occlusion, while vitreous hemorrhage developed in one patient with proliferative diabetic retinopathy. Optic atrophy occurred in one patient with severe PVR which was thought to be independent from Oxane HD tamponade.

Another frequent complication of Oxane HD is pain and photophobia (6, 7). Schatz et al have investigated the long-term intraocular tolerance of perfluorohexyloctane endotamponade in 18 patients with complicated retinal detachment. They have proposed that heavy silicone oil may have caused pain and photophobia by applying pressure over the ciliary body, which could have been prevented by filling silicone oil just behind the level of ciliary body (6). Mild pain and photophobia was also present in our cases. None of these patients had marked intraocular inflammation, and these complaints disappeared after silicone oil extraction. We believe that, besides ciliary body contact, the low viscosity of Oxane HD causes high motility inside the eye, leading to pain and photophobia.

Oxane HD also has been reported to cause steroid-resistant anterior granulomatous uveitis owing to its immunogenic property (21). Mild postoperative inflammation was also present in our cases; however, none of them showed the signs of anterior uveitis.

Emulsification is a frequent complication of unpurified and low-viscosity silicone oil, while it is not expected with ultrapurified heavy silicone oil (7). Emulsification develops when the silicone oil loses its surface tension, especially when left in the eye for long periods (7, 22, 23). The high surface tension of heavy silicone oil, as well as its short tamponade period, was thought to prevent emulsification in our cases.

The removal of heavy silicone oil is more difficult than the removal of standard silicone oil due to its higher density and surface tension. Heavy silicone oil should be removed with three-port pars plana approach using endoillumination, and aspiration needle with a viscous fluid injection syringe in aspiration mode. After completing the active aspiration procedure, silicone tipped backflush needle is usually required to remove the silicone oil remnants left over the retinal surface.

In this study, favorable postoperative results were obtained by using Oxane HD as an intraocular tamponade in cases with complicated retinal detachment. Oxane HD decreased postoperative PVR and redetachment rate by stabilizing the retina, and achieved better operative outcomes than those with standard silicone oil or long-acting gas tamponade. Also it enabled performing large inferior retinotomies in cases with retinal traction. Its complications were acceptable, and mostly due to its physical properties. As a result, Oxane HD appears to increase the anatomic success rates in cases with complicated retinal detachment and PVR; however, further studies are required to evaluate especially the toxic and mechanical complications of Oxane HD in long-term tamponade.

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