Interaction with intraocular lens materials: Does heavy silicone oil act like silicone oil?

Aylin Yaman, MD, A. Osman Saatci, MD, Sulen Sarıoğlu, MD, F. Hakan Öner, MD, Ismet Durak, MD

PURPOSE: To determine the interaction of heavy silicone oil with various intraocular lens (IOL) materials and whether heavy silicone oil covers the silicone IOL optic as silicone oil does.

SETTING: Department of Ophthalmology, Dokuz Eylul University, Izmir, Turkey.

METHODS: The study group comprised 5 poly(methyl methacrylate) (PMMA) IOLs, 4 foldable silicone IOLs, 5 foldable hydrophilic acrylic IOLs, and 5 foldable hydrophobic acrylic IOLs. Each IOL was bathed in balanced salt solution (BSS) for 10 minutes and then placed in heavy silicone oil dyed with Sudan Black for another 10 minutes. Afterward, each IOL was reimmersed in BSS for 5 minutes and examined under the light microscope. Digital images were analyzed to determine the optic area covered with heavy silicone oil.

RESULTS: The mean heavy silicone oil coverage was 7.05% ± 7.88% (SD) (range 1.13% to 20.54%) on PMMA IOLs, 100% on silicone IOLs, 12.17% ± 11.43% (range 1.25% to 31.52%) on hydrophobic acrylic IOLs, and 34.64% ± 13.28% (range 12.57% to 44.42%) on hydrophilic acrylic IOLs. Heavy silicone oil coverage of silicone IOLs was statistically significantly greater than the coverage of other IOL materials.

CONCLUSION: Heavy silicone oil acted the same as silicone oil and covered the entire surface of silicone IOLs.

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The compatability of various intraocular lens (IOL) materials and silicone oil has been investigated.[1–5] It is well-established that silicone oil manifests as a thick coating with droplet formation on the silicone IOL surface and adheres to the surface so tenaciously that it cannot be removed by instruments or injection of ophthalmic viscosurgical devices (OVDs).[1] The mean silicone oil coverage of silicone IOL optics varies between 80%[5] and 100%.[2] The viscosity of the oil does not affect the adherence.[3,5]

Proliferative vitreoretinopathy has a propensity for the inferior retina. Recently, silicone oil types heavier than water were introduced in eyes with complicated inferior retinal detachment having vitreoretinal surgery.[6] Heavy silicone oil alleviates the need for a face-down position postoperatively and effectively tamponades inferior breaks.

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From the Department of Ophthalmology, Dokuz Eylul University, Izmir, Turkey.

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Corresponding author: Aylin Yaman, MD, Koruturk Mah. Nar Sok, No: 17/2, Balcova, Izmir, 35335, Turkey.

We tested the interaction of heavy silicone oil with various IOL materials to determine whether the IOL interaction with heavy silicone oil differs from the interaction with regular silicone oil.

MATERIALS AND METHODS

Four IOL materials were tested in vitro to evaluate the adherence of heavy silicone oil to the IOL optic: Single-piece rigid poly(methyl methacrylate) (PMMA) (Crystal Type 1, Alcon Laboratories) (n = 5); 3-piece foldable silicone (Oculaid PC 420Y, Ophtec Laboratories) (n = 4); monoblock foldable hydrophilic acrylic (Auroflex FH 5575, Aurolab) (n = 5); and monoblock foldable hydrophobic acrylic (AcrySof SA30AL, Alcon Laboratories) (n = 5). A total of 19 IOLs were tested.

The method to visualize the adherence of heavy silicone oil (Oxane HD, Bausch & Lomb) to the IOL optic was modified from Öner et al.[5] and McLoone et al.[7] The heavy silicone oil was dyed using Sudan Black for better visualization of the heavy silicone oil droplets covering the IOL optic. In a test tube, 20 mg/mL of the dye was mixed with 1.0 mL of heavy silicone oil and the mixture was centrifuged at 10 000 cycles/min for 15 minutes to separate excessive dye from the heavy silicone oil. Each IOL was immersed first in balanced salt solution (BSS) for 10 minutes and then in the dyed heavy silicone oil for 10 minutes. The IOL was reimmersed in BSS for another 5 minutes and then examined under light microscopy (Olympus BX51, Olympus Optical Co. Ltd.). Digital images were taken using a 3CCD color

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Table 1. Percentage of heavy silicone oil coverage of each IOL and mean coverage of IOL types.

	Percentage of Coverage					
IOL Type	IOL 1	IOL 2	IOL 3	IOL 4	IOL 5	Mean Coverage
PMMA	1.13	2.87	3.27	20.54	7.45	7.05 ± 7.88
Silicone	100	100	100	100	—	100
Hydrophobic acrylic	31.51	7.65	1.25	9.30	11.15	12.17 ± 11.43
Hydrophilic acrylic	43.05	44.42	31.85	41.32	12.57	34.64 ± 13.28

IOL = intraocular lens; PMMA = poly(methyl methacrylate)

video camera (Olympus DP70, Olympus Optical Co. Ltd.) connected to a light microscope at an original magnification of ×1.25. The system was connected to a computer (Vestel), and image analysis was performed (BS 200D Image Analysis Software, BAB Imaging Systems Ltd.).

The area of heavy silicone oil droplets covering the IOL optic was measured in pixels with the image analysis system, using an interactive area-measurement method. The ratio of heavy silicone oil covering the optic to the total optic area was determined as the percentage of heavy silicone coverage. The data were analyzed using Kruskal-Wallis and Mann-Whitney *U* tests where appropriate.

RESULTS

The mean percentage of heavy silicone oil coverage of each IOL and the mean heavy silicone coverage of each IOL material group are shown in Table 1. The percentage of heavy silicone oil coverage was compared among the IOL materials (Table 2). Statistical comparison showed that heavy silicone oil coverage of silicone IOLs was significantly greater than the coverage of the other IOL materials.

DISCUSSION

Currently, surgical techniques are become increasingly sophisticated and surgical adjuncts are diversified. Anterior and posterior segment surgeries are becoming intermingled to some degree. The compatibility and interaction of new surgical agents with IOL materials are of interest, but sometimes cause confusion. We previously analyzed the interaction of IOLs with various viscosities of silicone oil and triamcinolone acetonide and looked at the staining characteristics of IOLs with several dyes (indocyanine green, fluorescein, and trypan blue).[5,8,9]

Vitreoretinal surgeons continue to look for tamponade agents with a high specific gravity to provide a safe and efficient long-term inferior tamponade. Two recently introduced commercial substances are Oxane HD (Bausch & Lomb) and Densiron 68 (Fluoron Co.).[10,11] Oxane HD (heavy silicone oil) is a mixture of silicone oil (Oxane 5700, Bausch & Lomb) and a mixed fluorinated and hydrocarbonated olefin (RMN3).[1] The density is 1.03 g/cm^3, the refractive index is 1.40, and the viscosity is 3800 cSt. Densiron-68 is a solution of perfluorohexyloctane and 5000 cSt silicone oil. The specific gravity is 1.06 g/cm^3 and the viscosity, 1387 cSt.

To our knowledge, there is no clinical report or experimental study of the interaction of heavy silicone oil and IOLs. Perhaps this is because most surgeons assume that heavy silicone oil will behave the same as silicone oil when it interacts with silicone IOLs. Wolf et al.[10] evaluated the efficacy and safety of heavy silicone oil in eyes with complicated retinal detachments involving the inferior part of the retina and excluded pseudophakic eyes with silicone IOLs with that assumption.

Our study clearly showed that heavy silicone oil behaved the same as silicone oil and adhered strongly to silicone IOLs, completely covering the surfaces. The mean heavy silicone oil coverage of silicone IOLs was 100%. The least adherence was observed in the group of PMMA IOLs, where the the mean heavy silicone oil coverage was 7.05%.

Table 2. Results of statistical analysis.

	P Value			
IOL Type	PMMA	Silicone	Hydrophobic Acrylic	Hydrophilic Acrylic
PMMA	—	.011*	.256	.016*
Silicone	.011*	—	.011*	.011*
Hydrophobic acrylic	.256	.011*	—	.016*
Hydrophilic acrylic	.016*	.011*	.016*	—

IOL = intraocular lens; PMMA = poly(methyl methacrylate)
*Statistically significant

As a result of our study, we recommend that silicone IOLs not be used in patients with current vitreoretinal disease or those who are at high risk for future vitreoretinal disease (ie, diabetic or highly myopic patients) and may require silicone oil or heavy silicone oil injection.

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