Eye (2012) 26, 1487–1489

www.nature.com/eye

CASE SERIES

The effects of intraocular silicone oil placement prior to iodine 125 brachytherapy for uveal melanoma: a clinical case series

Y Ahuja[1], KG Kapoor[1], RM Thomson[2], KM Furutani[3], RW Shultz[1], SL Stafford[3], S Dev[4], NE Abu-Yaghi[5], D Reynolds[6] and JS Pulido[1]

Abstract

Purpose **To investigate the role of silicone oil as an adjunct to iodine 125 (^{125}I) brachytherapy in attenuating radiation dose and reducing radiation retinopathy.**
Methods **A 16-mm COMS plaque loaded with ^{125}I seeds was simulated *in vitro* on an eye model containing silicone oil as a vitreous substitute using BrachyDose. The radiation dose ratio of silicone oil *vs* water to ocular structures was calculated at angles subtended from the centre of the eye. Silicone oil was then used in three choroidal melanoma patients who underwent 23-gauge vitrectomy, silicone oil placement, and ^{125}I brachytherapy.**
Results **Silicone oil reduced the ocular radiation dose *in vitro* to 65%. Radiation dose ratios on the retina increased from 0.45 to 0.99 when moving from points diametrically opposed to the plaque's central axis. In 10–24 months' follow-up, no patients have developed radiation retinopathy. Each patient required silicone oil removal and experienced cataract progression, and one also developed a retinal detachment.**
Conclusions **This study confirms that silicone oil attenuates radiation dose *in vitro*, and may protect against radiation retinopathy clinically in patients, however it requires extensive surgical interventions. Further studies in only very selected populations using silicone oil as an adjunct to ^{125}I brachytherapy will best elucidate its role in shielding radiation retinopathy.**
Eye (2012) **26,** 1487–1489; doi:10.1038/eye.2012.158; published online 31 August 2012

Keywords: retina; silicone oil; brachytherapy

Introduction

Although present brachytherapy is very effective in treating uveal melanoma, it has a marked pejorative effect on vision, especially for tumours near the fovea or optic nerve.[1] Techniques to preserve vision are needed. Though endoresection has been used, this technique involves disrupting the retina, which provides a natural barrier to extension of the tumour.[2] Recent preclinical studies suggest using intraocular silicone oil prior to iodine 125 (^{125}I) brachytherapy for uveal melanoma attenuates the radiation dose to vital ocular structures, potentially reducing the development of radiation maculopathy and papillopathy.[3] The authors report their own preclinical study results followed by clinical use of silicone oil as an adjunct to ^{125}I brachytherapy in three patients with choroidal melanoma.

Materials and methods

For our Monte Carlo simulations using the EGSnrc user-code BrachyDose[4] to study the effects of ^{125}I radiation in an ocular model, silicone oil was used as a vitreous substitute and compared with water (Figure 1). A 16-mm COMS plaque fully loaded with Best 2301 ^{125}I seeds was positioned nasally on a right eye model. Our primary outcome was the radiation dose ratio (of silicone oil *vs* water) to ocular structures at various angles (φ) subtended from the ocular centre (Figure 2). Angle φ is 0 degrees at the anterior axis of the model and φ is 90 degrees on the plaque's central axis near the plaque. The simulation results demonstrated that radiation dose ratios on the retina increased

[1]Department of Ophthalmology, Mayo Clinic, Rochester, MN, USA

[2]Department of Physics, Carleton University, Ottawa, Ontario, Canada

[3]Department of Radiation Oncology, Mayo Clinic, Rochester, MN, USA

[4]VitreoRetinal Surgery, PA, Edina, MN, USA

[5]Division of Ophthalmology, The University of Jordan, Amman, Jordan

[6]Central Minnesota Retina Specialists, Sartell, MN, USA

Correspondence:
Dr JS Pulido, Department of Ophthalmology, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA
Tel: +1 507 284-3721;
Fax: +1 507 284-4612.
E-mail: pulido.jose@mayo.edu

Received: 20 October 2011
Accepted in revised form: 11 June 2012
Published online: 31 August 2012

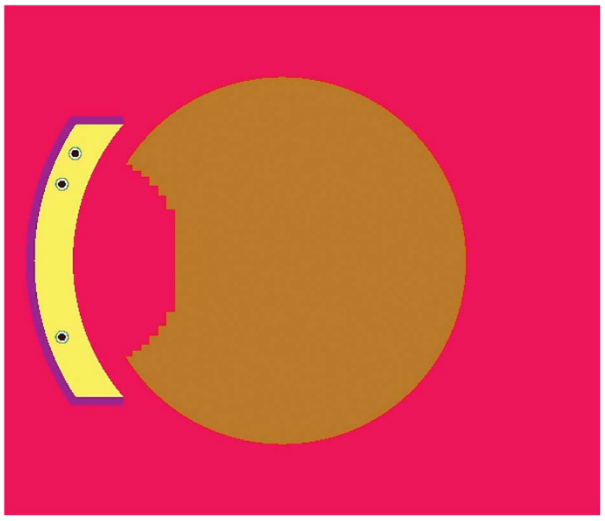

Figure 1 Model used for dose calculations with BrachyDose shown in a plane through the eye's centre. A 16-mm COMS plaque was fully loaded with Best 2301 ^{125}I seeds. Water phantom; silicone oil (100%) sphere to radius 1.08 cm. Water tumour modelled as 'cylinders' extending into the silicone oil sphere (height 5 mm from inner sclera).

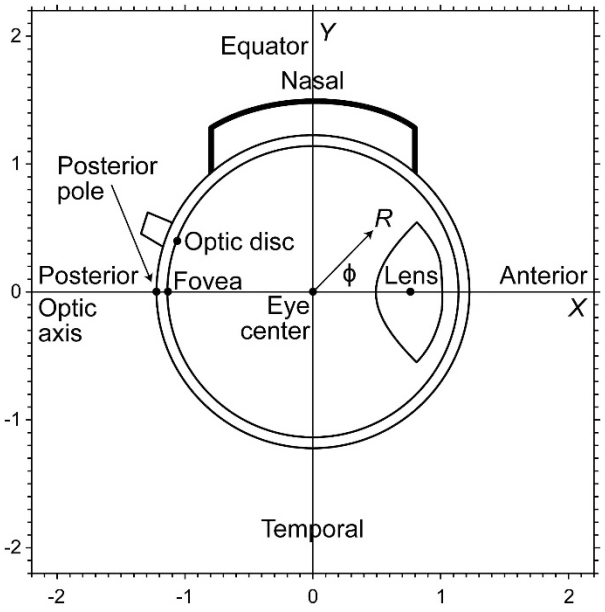

Figure 2 Diagram showing the configuration considered for dose calculations and defining the angle φ used in some of the figures. Angle φ is defined as follows: 90 degrees is on the plaque's central axis near the plaque; -90 degrees is on the plaque's central axis at the opposite side of the eye to the plaque. Right eye assumed.

from 0.45 to 0.99 when moving from points diametrically opposed from the plaque ($\varphi = -90$ degrees) to the plaque's central axis near the plaque ($\varphi = 90$ degrees)

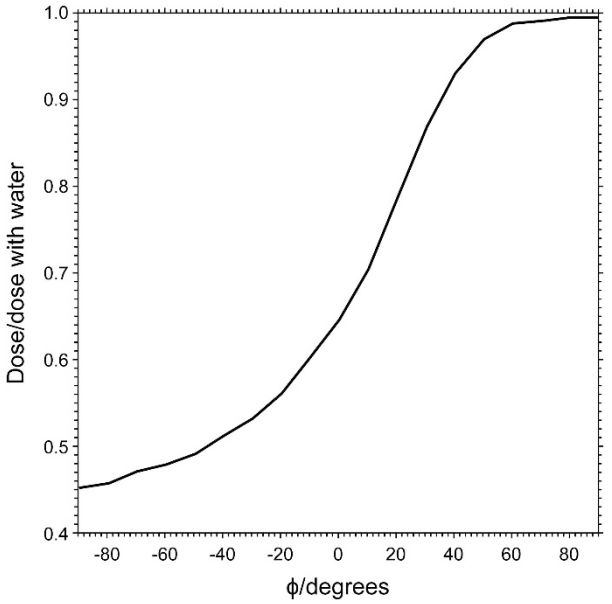

Figure 3 Ratio of doses at the radius of the retina (1.09 cm): doses for the configuration shown in Figure 1 (silicone oil sphere at eye centre; water elsewhere) to doses for water (no silicone oil). Both simulations include the plaque's Modulay backing and Silastic insert as well as interseed effects.

(Figure 3). Of significance, intraocular silicone oil reduced the radiation dose to ocular structures at the anterior–posterior ocular axis to 65% of the dose without silicone oil. (Figure 3).

Silicone oil was then used in three cases of posteriorly located medium or large choroidal melanomas, in which each patient underwent microincision vitrectomy, endolaser, 1000-centistoke silicone oil placement, and ^{125}I plaque with 80–85 Gy. Following determination of proper placement using either diaphanoscopy or indirect ophthalmoscopy, a dummy plaque was sutured in place and ultrasonography was used to determine proper placement. Once it was felt that the plaque would be sutured in proper position, a 23- or 25-gauge vitrectomy was performed. After an air–fluid exchange, the radioactive plaque was then sutured in place and then a silicone–air exchange was performed.

Case reports

Case 1

A 58-year-old woman presented with a $16 \times 13 \times 9$ mm variably pigmented mushroom-shaped choroidal melanoma (T2bN0M0) with borders 0 mm nasal to the disc and 4 mm posterior to the ora in her left eye and vision of 20/40. She underwent 23-gauge vitrectomy, tumour biopsy, endolaser, silicone oil placement, and a 20-mm ^{125}I plaque. Silicone oil was removed 5 months

later, and on 2-year follow-up her tumour has decreased in size without any evidence of radiation retinopathy, but her visual acuity has declined to 2/200 due to a dense cataract.

Case 2

A 69-year-old woman had a $16 \times 13 \times 3$ mm posterior multilobed pigmented choroidal melanoma (T2aN0M0) in her right eye with borders 5mm temporal to the fovea and extending to the ora at 9 o'clock, with vision of 20/30. She underwent 23-gauge pars plana vitrectomy with biopsy, endolaser, silicone oil placement, and a 20-mm ^{125}I plaque. Silicone oil was removed 2 months later, and on 22 months' follow-up her tumour remains regressed without evidence of radiation retinopathy, and most recent visual acuity of $20/40-1$.

Case 3

A 58-year-old woman had an $11 \times 8 \times 2.5$ mm oval pigmented choroidal melanoma (T2aN0M0) along the inferior arcade in her right eye that was 1.5 mm inferotemporal to the disc and 0.7 mm from the fovea with associated subretinal fluid. She underwent 23-gauge vitrectomy with biopsy, endolaser, silicone oil placement, and 16 mm ^{125}I plaque placement. After 7 months, she was evaluated for silicone oil removal and cataract surgery, and was found to have an inferior rhegmatogenous retinal detachment with significant anterior vitreous contraction, requiring scleral buckle, vitrectomy, and endolaser. On 10 months' follow-up she is $20/200+2$ with tumour base regression and no radiation retinopathy.

Discussion

To date, none of our three patients have developed radiation retinopathy. Radiation retinopathy typically occurs 18 to 24 months after brachytherapy,[5,6] suggesting a potential protective effect of silicone oil in at least the two cases with longer follow-up. Nevertheless, each of these patients required additional operation for silicone oil removal, experienced cataract progression within, and one patient also developed a retinal detachment.

This study confirms that silicone oil attenuates radiation dose *in vitro*, and may protect against radiation retinopathy clinically in patients. However, we are concerned about the extensive surgery involved and would recommend limiting its use to only very special cases such as posterior pole melanomas in functionally monocular patients. It is critical to consider the risks of silicone oil use in these cases, including multiple surgeries and cataract progression. To our knowledge, there is no previous clinical data in the literature supporting silicone oil decreasing radiation retinopathy. Further studies are needed to elucidate the precise role of silicone oil as an adjunct to ^{125}I brachytherapy in shielding radiation retinopathy.

Summary

What was known before

- Silicone oil may attenuate radiation *in vitro.*

What this study adds

- Confirms silicone oil attenuates radiation dose *in vitro.*
- Shows for the first time that silicone oil attenuates radition retinopathy clinically, but this comes with extensive additional surgery.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

This study was supported in part by an unrestricted grant from Research to Prevent Blindness Inc., NY and from Terry and Judith Paul.

References

1 Markovic SN, Erickson LA, Rao RD, Weenig RH, Pockaj BA, Bardia A *et al*. Melanoma Study Group of Mayo Clinic Cancer Center. Malignant melanoma in the 21st century, part 2:staging, prognosis, and treatment. *Mayo Clin Proc* 2007; **82**(4): 490–513.
2 Damato B, Groenewald C, McGallliard J, Wong D. Endoresection of choroidal melanoma. *Br J Ophthalmol* 1998; **82**(3): 213–218.
3 Oliver SN, Leu MY, DeMarco JJ, Chow PE, Lee SP, McCannel TA. Attenuation of iodine 125 radiation with vitreous substitutes in the treatment of uveal melanoma. *Arch Ophthalmol* 2010; **128**(7): 888–893.
4 Thomson RM, Taylor REP, Rogers DWO. Monte Carlo dosimetry for 125I and 103Pd eye plaque brachytherapy. *Med Phys* 2008; **35**(120): 5530–5543.
5 Quivey JM, Augsberger J, Snelling L, Brady LW. 125I plaque therapy for uveal melanoma: analysis of the impact of time and dose factors on local control. *Cancer* 1996; **77**(11): 2356–2362.
6 Quivey JM, Char DH, Phillips TL, Weaver KA, Castro JR, Kroll SM. High intensity 125iodine 125I plaque treatment of uveal melanoma. *Int J Radiat Oncol Biol Phys* 1993; **26**(4): 613–618.