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*Editorial*

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## Fluorosilicone oil for retinal detachment

The paper by Gremillion and colleagues on the use of fluorosilicone oil in the treatment of retinal detachment reintroduces the question of the role of the physical properties of silicone oil used in posterior segment surgery.

In the beginning Dow Corning manufactured a material called 360 Fluid Medical Silicone.<sup>1</sup> Its medical indications included the lubrication of plastic syringes and the coating of rubber catheters. Injection into human tissues was specifically excluded. This fluid was polydimethylsiloxane and was identical to laboratory grade 200 fluid silicone. Toxicological investigation prior to its use for these purposes had shown that silicone 360 caused little or no reaction when injected into tissues, so it was designated a 'medical fluid'.

Stone is credited with having been the first to inject silicone into the vitreous cavity of an animal.<sup>2</sup> In a now classic series of papers describing various forms of alloplasty in and around the eye he reported 'very little reaction' to liquid silicone injected into the rabbit vitreous after two years. Four years later Cibis published his early results in the human eye.<sup>3</sup>

Several years passed during which silicone was used by a small group of surgeons who developed the pioneering work of Cibis. Others learnt the techniques and developed them further, so that now in 1990 silicone is accepted as a valid technique in the treatment of complex vitreoretinal disease.

A wide variety of silicones have been used in vitreoretinal surgery, and some have been compared by Gabel and colleagues.<sup>4</sup> The decision to use a particular viscosity seems to have been based on commercial availability, the injecting system, and perhaps some consideration for theoretical advantage in the prevention of complications. Owing to the very wide variety of cases treated and marked differences in method and definition of complication it is difficult to draw any conclusions on the most suitable material to use at present.

Two principal varieties of silicone have been used as a retinal tamponade, polydimethylsilicone and fluorosilicone. The first has a density very slightly less than water and the second slightly greater. Thus fluorosilicone displaces water upwards in a two-phase mixture and should provide a more effective tamponade for inferior retinal breaks.

Dimethylsilicone has been used most widely as a long lasting tamponade following instrument membrane peeling in cases of proliferative retinopathy and giant retinal tear. The need for a tamponade in proliferative vitreoretinopathy relates to the underlying rhegmatogenous nature of this complication of retinal detachment, and in cases of giant tear to the need to maintain the posterior flap and retinal pigment epithelium in stable contact until the cryoadhesion becomes firmly established. Where inferior breaks exist, special care

needs to be taken to ensure their adequate closure if the less dense material is employed.

When silicone became more widely used there was still uncertainty about the potential toxicity of the oil to the retina, so that it was removed in most cases. When the early toxicity experiments were repeated with controls who were operated upon<sup>5</sup> concern for the potential harmful side effects of silicone on the retina moved to the lens, and the cataract that often followed its use was attributed to some effect of silicone on metabolic transfer across the posterior surface of the lens.<sup>6</sup> Considerable doubt now exists that this is the case, with an increasing understanding of the global pathological changes which follow severe proliferative vitreoretinal disease.<sup>7</sup>

However, the most significant and unavoidable complication relating to the silicone oil itself remains, and that is what is called emulsification. At the present time it is the principle reason for recommending that silicone be removed wherever possible.

Gremillion and his coworkers had to remove their silicone very early – from two to eight weeks after surgery – because emulsification occurred in over 90% of cases. The redetachment rate following removal was nearly 25%, emphasising the very great difficulty which surrounds the decision to remove silicone in many patients. This dilemma underlines the importance of finding an answer to the question of foaming at the surface of silicone oil.

The possible relation between viscosity and emulsification has been investigated experimentally by Crisp and colleagues,<sup>8</sup> who found that low viscosity oils were more likely to emulsify than those with high viscosity. Viscosity is related closely to chain length and therefore to molecular weight, so that silicone oils with a homogeneous large molecular weight composition should be less likely to emulsify. The only report of the clinical use of very high viscosity silicone was from Constable, *et al.*,<sup>9</sup> who found no emulsification in a follow-up of three months to two years. They described some difficulty in injecting the oil, and no patient had the oil removed.

The apparent relationship between molecular weight and the risk of emulsification has led to the development of a new type of polydimethylsiloxane, which has been processed to remove low molecular weight fractions.<sup>10</sup> The fact that even high viscosity silicone oils contain significant amounts of short chain and cyclic fractions should allow the process of their removal to lead to less emulsification. Early personal experience with 1000 cSt new silicone has led to the conclusion that it has a high risk of severe early emulsification, whereas the 5000 cSt material is much less likely to emulsify and is acceptable. In Gremillion and coworkers' cases the fluorosilicone used for 28 out of 30 cases was 300 cSt viscosity only.

Analysis of 5000 cSt material removed from cases where emulsification has been a significant problem has shown that it has changed during or after injection (Burkhardt J, personal communication). This may lead to the possibility that the variation in presentation of emulsification may be due to the combination of the viscosity of the oil and the manner in which it is injected.

The need to remove cyclic siloxanes from the silicone oil may be important in the prevention of inflammation, since they are known to be toxic to the cornea<sup>11</sup> and might be harmful to the retina.<sup>12</sup> This can be done during the same manufacturing process which removes low molecular weight fractions and should further reduce doubts regarding the suitability of silicone oil for injection into the eye. However, it should be noted that there is no evidence that the presence of low molecular weight or catalyst residues is harmful to the retina. One report found a marked iris reaction when high viscosity fluorosilicone, which had been processed to remove low molecular weight components and catalyst residues, was injected into the vitreous of a vitrectomised rabbit eye.<sup>13</sup> There is however no evidence that these residues, if not removed, result in a more severe reaction using either dimethyl silicone or fluorosilicone.

The fact that there was a high incidence of emulsification after the use of fluorosilicone in Gremillion and co-workers' cases is probably the result of the use of low viscosity material. High viscosity homogeneous fluorosilicone can be manufactured,<sup>13</sup> though with more difficulty than with dimethyl silicone, and could provide a valuable high density fluid which would be effective in the tamponade of inferior breaks after vitrectomy.

Cibis in his earliest publication<sup>3</sup> reported the use of polydimethylsiloxane and fluorosilicone in rabbit eyes and found no difference in response. This might encourage us to look for alternative material with differing physical properties to extend our surgical range in the treatment of complex vitreoretinal disease.

At present it would seem prudent to use 5000 cSt polydimethyl silicone oil prepared for specific use within the eye. Anything else might expose the surgeon to potential medicolegal complications which, despite existing lack of hard evidence, might be difficult to defend.

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## Fluorosilicone oil for retinal detachment.

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