INVESTIGATION INTO THE CAUSES OF POST-OPERATIVE CALCIFICATION IN INTRAOCULAR LENSES

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1. INTRODUCTION
Hydrophilic acrylic polymers are routinely used in the manufacture of intraocular lenses for implant in patients suffering from cataracts. However, late post-operative complications caused by calcification\(^1\), has recently been identified as a potential problem that results in visual impairment after the surgery.

2. Cataract and the Eye
A cataract is clouding of the eyes natural lens, due to the build up of proteins on the surface, that over a period of time causes reduced vision. This can be cured by replacing the natural lens with an artificial lens, an “intraocular lens (IOL),” although the same complication can then still occur on the IOL after a period of time.

3. Calcification of Intraocular Lenses
Calcification is the build up of deposits of calcium on the surface of an IOL, causing repeated blurred vision. Calcification results in the need for repeated cataract surgery. If research can identify the causes of the calcification it will be able to help in improving the materials and increasing the lifespan of IOLs.

4. AIMS
The aim of this research was to contribute to investigations into the causes of calcification. The scope and extent of calcification was examined by using various surface and thermal analysis techniques. Comparing these to neat controls provides a good understanding of the rate of calcification.

5. METHODS
Poly(meth)acrylate (PMMA) in disc form (10mm x 2.5mm) was sterilised using gamma radiation and also left un-sterilised. These were immersed in a Simulated Eye Fluid Solution (SEFS), \(\text{CaCl}_2\) 3.87mM, \(\text{K}_2\text{HPO}_4\) 2.32mM in tri buffer at pH 7.4 at 37°C used to study the rate of calcification over period of 9 weeks.

6. Thermomechanical Analytical Techniques

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D = \frac{m^2 \pi l^2}{4^2}
\]

\(m\) = Gradient of Linear portion
\(l\) = Thickness of sample (0.0025m)
\(D\) = Diffusion Coefficient.

Gamma sterilised PMMA immersed in SEFS Diffusion Coefficient: \(1.67 \times 10^{-2}\) m\(^2\) s\(^{-1}\)
Un-sterilised PMMA immersed in SEFS Diffusion Coefficient: \(1.94 \times 10^{-2}\) m\(^2\) s\(^{-1}\)

7. Gravimetric Analysis
This was carried out by calculating weight gain/loss of the PMMA discs over the period of 9 weeks. The Data obtained is showing a clear fickian profile whereby a diffusion coefficient can be calculated at the shorter times, using the following equation:

8. Scanning Electron Microscopy (SEM)
Images of impurities present on the surface, were observed as crystal like that started developing as soon as 1 day after immersion in SEFS. These deposits were identified by Energy Dispersive X-Ray Analysis (EDX) as calcium containing.

9. Contact Angle Analysis
Used to capture a water droplet falling onto the surface of a polymer, to give an indication of the degree of hydrophilicity of the polymer. From the contact angle analysis it was noted that the discs within the SEFS over a period of time had a decreasing contact angle, which is an increased degree of wettability.

References
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