Intraocular lens durability after a mean of 10.9 years' implantation in humans

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Abstract

***Aims/background*—To clarify whether intraocular lens (IOL) implantation in the human eye affects the durability of polymethylmethacrylate over an average period of 10.9 years.**

***Methods*—Shearing stress and extent of damage following neodymium (Nd):YAG laser application to 18 study and 12 control optics were examined.**

***Results*—No significant difference was found between the study and the control IOLs in shearing stress and extent of damage following Nd:YAG.**

***Conclusion*—An average 10.9 years' implantation in humans does not affect either the shearing stress or extent of damage following Nd:YAG shots of polymethylmethacrylate.**

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Polymethylmethacrylate (PMMA) has been widely used to make intraocular lens (IOL) optics and haptics, and many studies of histopathological changes,[1] damage by neodymium (Nd):YAG laser,[2] scanning electron microscopic findings,[3] and chemical analysis of PMMA[4] have been reported. However, no reports have been published about PMMA durability implanted in humans over long periods. We investigated the shearing stress and the extent of damage following Nd:YAG shots, as an index of mechanical durability of PMMA optics implanted in human eyes for an average of almost 11 years.

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Material and methods

Eighteen Binkhorst four loop iris clip IOLs with PMMA optics (Morcher Co, Germany) were removed because of bullous keratopathy or IOL exchange caused by extensive corneal endothelial cell loss (Fig 1). They had been implanted for an average of 10.9 years (range 5.8–14.5 years). The removed IOLs were stored in sterile balanced salt solution (BSS) in the dark and at room temperature, and were cleaned by ultrasonics (Ultrasonic Generator UT304Ftm, Sharp Co, Japan) for 10 minutes (5 minutes, twice) in distilled water. Twelve control IOLs (Fig 2) had been stored in 0.1% NaOH a standard sterilising solution, by the manufacturer for the same average time. All the control IOLs were stored in the dark and at room temperature as these are the conditions we usually store IOLs in the hospital before use.

PMMA durability was measured as follows. The shearing stress was measured by a three point bending test using Universal Testing Machine Type 4301R (Instron Corp, USA). Fifteen study IOLs and nine control IOLs were used. The IOL was placed on two point bases, and forces (P) were applied vertically to the centre of the optic until it broke into two pieces. The area (A) then was measured after forces (P) were applied vertically to the centre of the optic until it broke into two pieces, with the two pieces have a same sectional area.

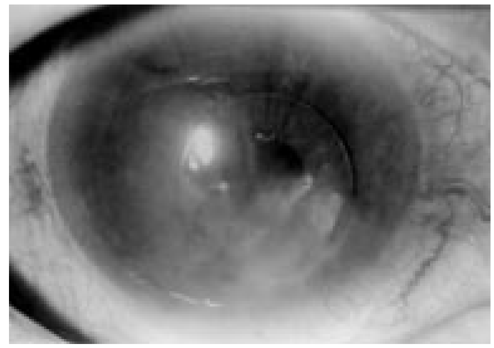

Figure 1 Anterior segment photograph of an eye in which it was planned to remove the IOL because of extensive corneal endothelial cell loss.

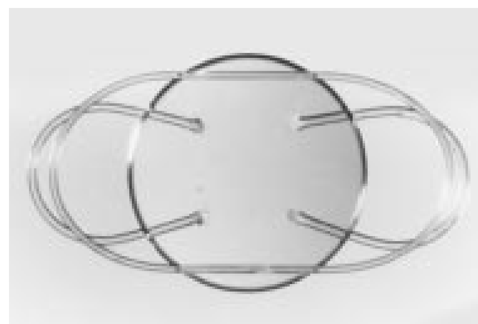

Figure 2 Photograph of the control Binkhorst four loop IOL.

The broken IOLs were photographed using a three charge couple device camera and were analysed quantitatively using image analyser. The mean shearing stresses (t = P/A) of the study IOLs and the control IOLs were compared. The data were analysed to determine if a correlation existed between the implantation period and the shearing stress in the study IOLs.

To examine the PMMA damage in three study IOLs and three control IOLs following Nd:YAG laser application, a Hoya-Shaplan Type 702R (Hoya Corp, Japan) was used. The Nd:YAG laser was set at Q switch mono mode with a spot size of 20 µm. A 2.0 or 3.0 millijoule (mJ) beam, the normal intensity of which is 0.7 mJ during clinical posterior capsulotomy, was aimed at the posterior IOL surface. Ten laser applications were made on each IOL. Damage was measured by light microscopy at 100 times normal magnification according to a method previously described.[2] The extent of the damage in the form of a circular pit or a star-shaped crack was determined by its diameter, and a linear crack was determined by its greatest dimension.

Results and discussion

Since Dr Harold Ridley performed the first implantation of an IOL, PMMA has been widely used for optic and haptic IOLs. However, no reports have been published about PMMA durability when implanted in humans over long periods. In study IOLs, the mean shearing stress was 1.51 kg force/mm^2 (kgf/mm^2), and in control IOLs, it was 1.40 kgf/mm^2. No statistically significance difference was found between the study and control IOLs (Mann–Whitney test). The correlation ratio between duration of implantation and shearing stress in the study IOLs was 0.12, and no statistical correlation was found. Almost all the Nd:YAG laser induced damage was in the form of circular pits or star-shaped cracks, and the linear crack-type PMMA damage was rarely seen in either IOLs. We could not seen any difference in the types of Nd:YAG laser induced PMMA damage in either removed or control IOLs. The mean extent of damage following Nd:YAG applications was not significantly different between the study and control IOLs (Mann–Whitney test). These results indicated that the strength of the PMMA did not decrease after an average 10.9 years of implantation in human eyes. Recently, new IOLs, such as silicone, hydrogel, and soft acrylic have been developed for small incision cataract surgery. However, the durability of these materials over long period has not been established. Further investigation on the durability of these new materials and careful follow up should be performed. We conclude that an average of 10.9 years' implantation in humans does not affect either the shearing stress or extent of damage following Nd:YAG shots of PMMA. We also reaffirm that PMMA is a useful and safe material for IOLs.

The authors have no proprietary interest in any product or instrument used in this study.

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