Analysis of Fluorescein Staining of Different Intraocular Lens Types

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Introduction

It is well established that topically or systemically applied fluorescein penetrates the eye and can be measured in the aqueous humour of the anterior chamber. So far no clinical cases of intraocular lens implant staining have been reported in literature. Recently we observed a transient discoloration of a hydrophilic IOL in one patient after local use of fluorescein eye drops (Hurtikova & Gerding, Poster #929, SOG 2017). Since little data is available on the staining of intraocular lenses by fluorescein, a systematic laboratory examination was performed with lenses composed of PMMA, silicon, hydrophobic acrylate and hydrophilic acrylate.

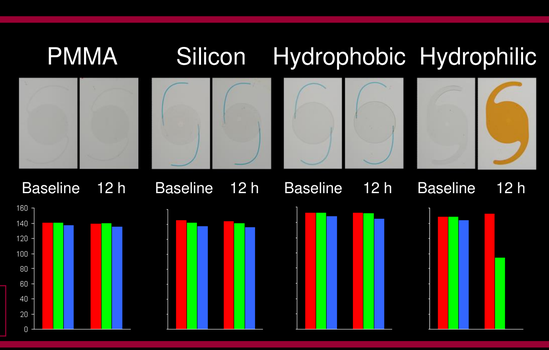


Fig. 1

Fig.1: Basic test results of lens staining in a 10% solution of fluorescein (Fluorescein 10% Faure, Fa. Curatis, Liestal, Switzerland). Above: Transillumination photographs at baseline and after 12 hours of incubation. Below: RGB-digital score (8 bit resolution) of the red, green and blue transmission. Transmission of blue light is zero after 12 hours in the hydrophilic acrylic lens. Lens types were: PMMA – CeeOn 811C, Pharmacia, Silicon – Tek Lens 411S, Tekla, Hydrophilic – Acrysof MA50BM, Alcon, Hydrophobic – MicroCryl MC X 125 ASP, Dr. Schmidt.

Figs. 2a-e

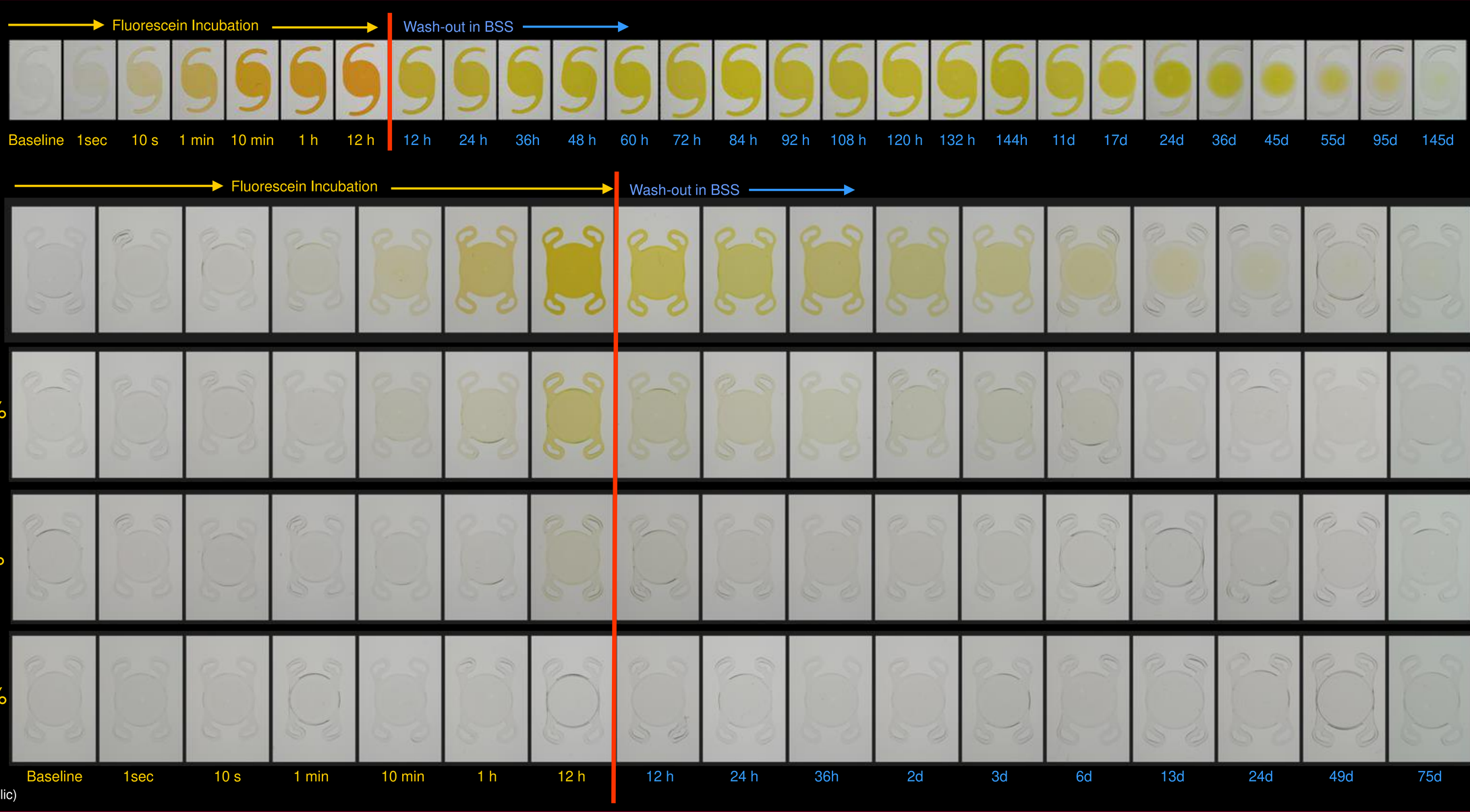
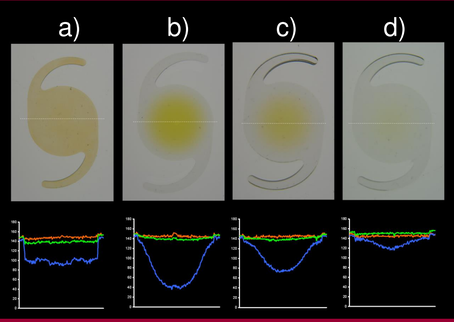


Fig. 3



Blue light transmission in the lens optic part (measured along the horizontal white line) during staining (10% fluorescein after 10 sec, b)) and subsequent wash-out of dye in balanced salt solution (BSS) after 24 days (cl), 49 days (c)), and 75 days (d)).

Fig. 4

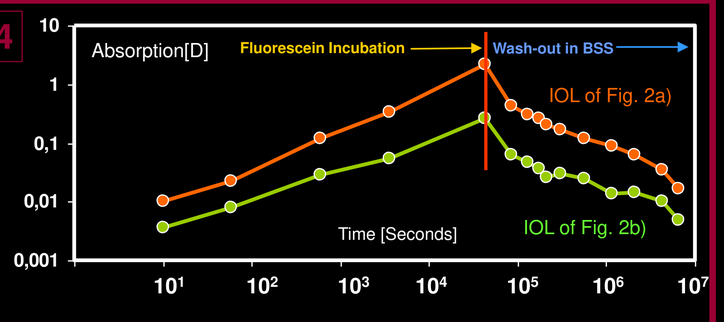
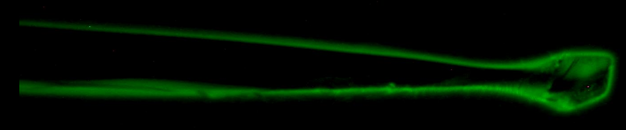


Fig. 5

Similar condition to the experiment in Fig. 2a



Fluorescence microsopy, transversal micro-section (35 µm) through the middle of the optic part of a hydrophilic IOL (MC X 125 ASP, Dr. Schmidt) stained for 12 h in 10% of fluorescein. The right shows the margin of the optic part.

Material and Methods

Intraocular lenses made of different materials (polymethylmetacrylate, hydrophobic acrylate, hydrophilic acrylate, silicone) were incubated according to a standard protocol in different concentrations of fluorescein (10%, 0.5%, 0.05%, 0.005%, 0.0005%, solved in balanced salt solution (BSS)) and discoloration was documented by digital photography taken in a trans-illumination setting under standardized light intensities after 1, 10 and 60 seconds, 10 minutes, 1 hour, and 12 hours. Wash-out of dye was documented during incubation in BSS up to 4.5 months. Fluorescein solved from stained lenses in BSS was photometrically measured (results not shown here). All incubations were performed under sterile conditions at 37°C. Staining intensity of digital images was measured using RGB-analysis functions implemented in the Image J software package. Micro-sections of discoloured lenses were examined by fluorescence microscopy.

Results

Results of a basic test using maximal fluorescein concentrations (10 %) are presented in Figure 1 . Only hydrophilic acrylic lenses showed uptake of fluorescein after 12 hours of dye exposure. All lenses composed of other materials showed little to no uptake of fluorescein. Therefore all subsequent experiments were performed only with hydrophilic acrylic intraocular lenses. The complete panel of coloration and clearing of hydrophilic acrylic lenses following incubation with fluorescein solutions of 10%, 0.5%, 0.05, 0.005, and 0.0005% are presented in Figures 2 a-e. Discoloration was visible and measurable down to a fluorescein concentration of 0.005%. During follow-up a progressive clearing of lens staining occurred. Complete clearing occurred during follow-up in lenses incubated with 0.005% of fluorescein (Fig. 2d). Measurement of the spatial distribution of deposited dye during wash-out indicated early disappearance on lens haptics and periphery of the optic part. Dye remained longest in the centre of the lens (Fig. 3). Quantitative results of dye deposition in the centre of lenses during incubation and wash-out of lenses in Figs. 2 b&c are exemplified in Fig. 4. The progression of discoloration during dye incubation indicates a 1. order kinetics. The wash out kinetics indicates a higher order process. The unequal disappearance of discoloration within the lens during wash-out can be explained by the inhomogenous distribution of dye within the lenses, as demonstrated in Figure 5, and by the unequal IOL thickness at different lens positions.

Conclusions

Results of these experiments indicate that a discoloration of intraocular hydrophilic acrylic intraocular lenses can occur after exposure to relatively low concentrations of fluorescein dye (0.005%). In patients with low body weight, who repeatedly receive local eye drops containing fluorescein in addition to a maximal dose of fluorescein for retinal angiography the dye concentration in body fluid and the aqueous may theoretically reach a level that might be sufficient to result in discoloration of hydrophilic acrylic intraocular lenses. As our experiments indicate, the discoloration of hydrophilic acrylic intraocular lenses after exposure to fluorescein spontaneously disappears.