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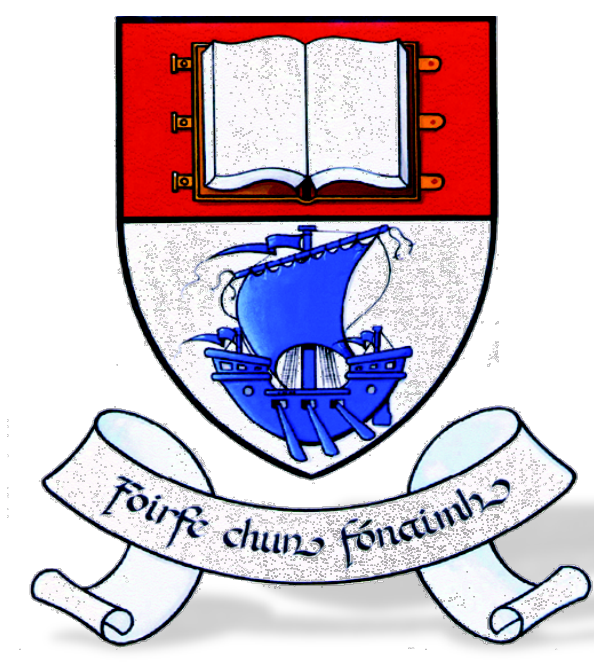
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Macular pigment levels increase following blue-light filtering intraocular lens implantation

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INTRODUCTION

Age-related macular degeneration (AMD), which damages central vision, is the most common cause of age-related blindness in the western world. There is a growing body of evidence suggesting that oxidative stress is important in the pathogenesis of this condition and that cumulative short-wavelength (blue) light damage plays a role. Macular pigment (MP), consisting of the carotenoids: lutein (L), zeaxanthin (Z) and meso-Z, has a maximum absorption at 460nm and protects the retina from (photo)-oxidative injury.

Alcon have been producing a yellow (blue-light filtering) IOL, the Alcon AcrySof Natural SN60AT® (ANIOL) since the year 2000. The ANIOL is similar to the standard, and commonly used, AcrySof SA60AT single-piece acrylic IOL (AIOL); however, it has a blue-light filtering capacity. The ANIOL was one of the first foldable IOLs to imitate the transmittance of the natural crystalline lens by combining a UV blocker with a covalently bound chromophore that partly absorbs light in the 400 to 500 nm spectral range.

PURPOSE

This study was designed to investigate whether the blue-light filtering properties of the ANIOL implanted during cataract surgery impacts on MP optical density (MPOD).

SUBJECTS and METHODS

Forty two patients scheduled for cataract surgery were recruited into the study. These patients all had pre-operative best corrected visual acuity rating (BCVAR) of at least 0.5 (logMAR) in the study eye. Patients were randomised to have either the standard AIOL (controls) or the ANIOL implanted at the time of cataract surgery. The spatial profile of MPOD (i.e. at 0.25°, 0.5°, 1° and 1.75° eccentricity) was measured with the Macular Densitometer™ using customised heterochromatic flicker photometry (cHFP) one week pre-operatively and one-week post-operatively, and at three, six and 12 months following surgery [Fig. 1]. Serum concentrations of L and Z were also measured by high-performance liquid chromatography (HPLC) at each study visit [Fig. 2].

Figure 1. The Macular Densitometer™

Figure 2. Agilent 1200 HPLC series



RESULTS

Of the 42 patients recruited into the trial, 30 attended all study visits (1 week pre-surgery, 1 week post-surgery, three-month visit, six-month visit, and 12-month visit [V1, V2, V3, V4, and V5, respectively]). One patient from the AIOL group dropped out after V1, two after V2, and two after V4 (n = 5 drop-outs in total). Three patients from the ANIOL group dropped out after V1, two after V2, and two after V4 (n = 7 drop-outs in total). Reasons for drop-out were as follows: patient illness (non-ocular pathology); patient deceased; logistics of transport; not interested in participating further.

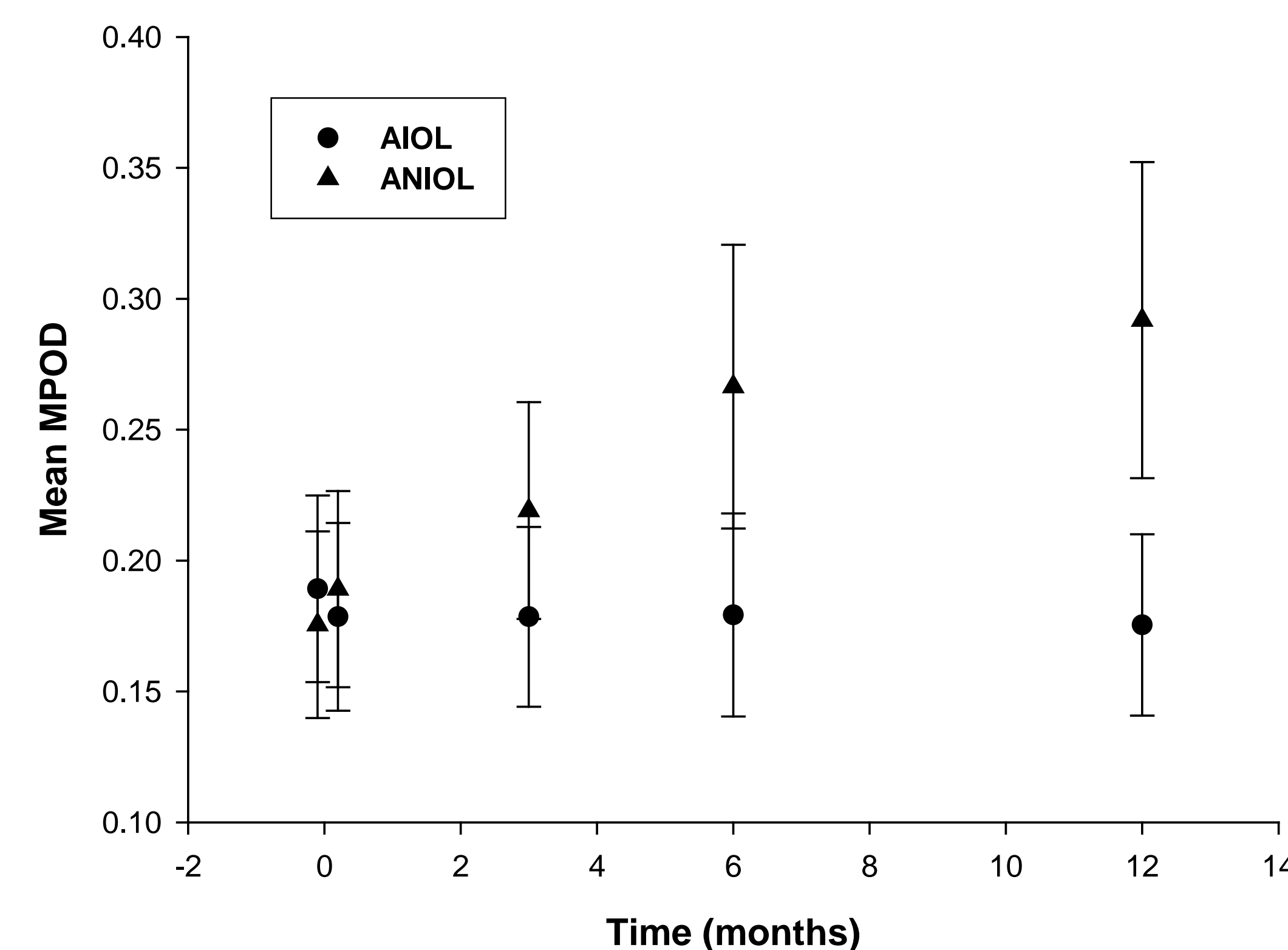
Macular Pigment Optical Density

We conducted a repeated measures analysis of average MPOD across the retina, measured at each of five study visits using a general linear model approach, with lens as a between-patients factor. This resulted in a statistically significant time/lens interaction effect, which remained significant (p < 0.05) using any of the standard corrections for violation of sphericity. It is clear from the means plots of Fig. 3 and MPOD values presented in Table 1, how this significant time/lens interaction effect arises: MPOD increases with time (at least for some patients) in the ANIOL group, but remains virtually static in the AIOL group.

Table 1.

AIOL									ANIOL									
Subject	V1	V2	V3	V4	V5	V3-V2	V4-V2	V5-V2	Subject	V1	V2	V3	V4	V5	V3-V2	V4-V2	V5-V2	
2	0.09	0.07	0.11	0.07	0.07	0.04	0	0	3	0.28	0.29	0.3	0.36	0.39	0.01	0.07	0.1	
5	0.4	0.45	0.38	0.43	0.4	-0.07	-0.02	-0.05	6	0.36	0.21	0.32	0.34	0.34	0.11	0.13	0.13	
7	0.3	0.17	0.14	0.11	0.12	-0.03	-0.06	-0.05	8	0.09	0.12	0.3	0.43	0.45	0.18	0.31	0.33	
11	0.03	0.07	0.06	0.02	0.03	-0.01	-0.05	-0.04	9	0.03	0.02	0.01	0.01	0	-0.01	-0.01	-0.02	
12	0.05	0.01	0	0.01	0	-0.01	0	-0.01	10	0.12	0.1	0.07	0.07	0.06	-0.03	-0.03	-0.04	
14	0.43	0.38	0.38	0.42	0.37	0	0.04	-0.01	17	0.22	0.25	0.28	0.17	0.25	0.03	-0.08	0	
16	0.21	0.27	0.29	0.32	0.26	0.02	0.05	-0.01	19	0.37	0.43	0.28	0.38	0.52	-0.15	-0.05	0.09	
18	0.18	0.13	0.19	0.19	0.25	0.06	0.06	0.12	20	0.04	0.06	0.07	0.15	0.08	0.01	0.09	0.02	
21	0.33	0.28	0.3	0.27	0.27	0.02	-0.01	-0.01	22	0.12	0.17	0.26	0.36	0.47	0.09	0.19	0.3	
27	0.14	0.13	0.09	0.09	0.11	-0.04	-0.04	-0.02	26	0.13	0.32	0.44	0.58	0.54	0.12	0.26	0.22	
29	0.16	0.1	0.07	0.15	0.12	-0.03	0.05	0.02	40	0.17	0.11	0.08	0.08	0.11	-0.03	-0.03	0	
32	0.12	0.13	0.12	0.12	0.16	-0.01	-0.01	0.03	Mean	0.18	0.19	0.22	0.27	0.29	0.03	0.08	0.10	
34	0.15	0.13	0.15	0.13	0.12	0.02	0	-0.01	SD	0.12	0.12	0.14	0.18	0.20	0.09	0.13	0.13	
Mean	0.20	0.18	0.18	0.18	0.18	0.00	0.00	0.00										
SD	0.13	0.13	0.12	0.14	0.12	0.04	0.04	0.04										

Figure 3.



Serum Lutein and Zeaxanthin

There were no significant serum L effects observed over the study period [Fig. 4]. There was a significant time effect for serum Z over the study period (repeated measures, general linear model, e.g. using Huynh-Feldt correction for sphericity, p = 0.038), but not a significant time/lens interaction (p > 0.05 for all tests) [Fig. 5]. Thus, serum Z was significantly different at different time points, but this was true in both the AIOL and ANIOL groups.

Figure 4.

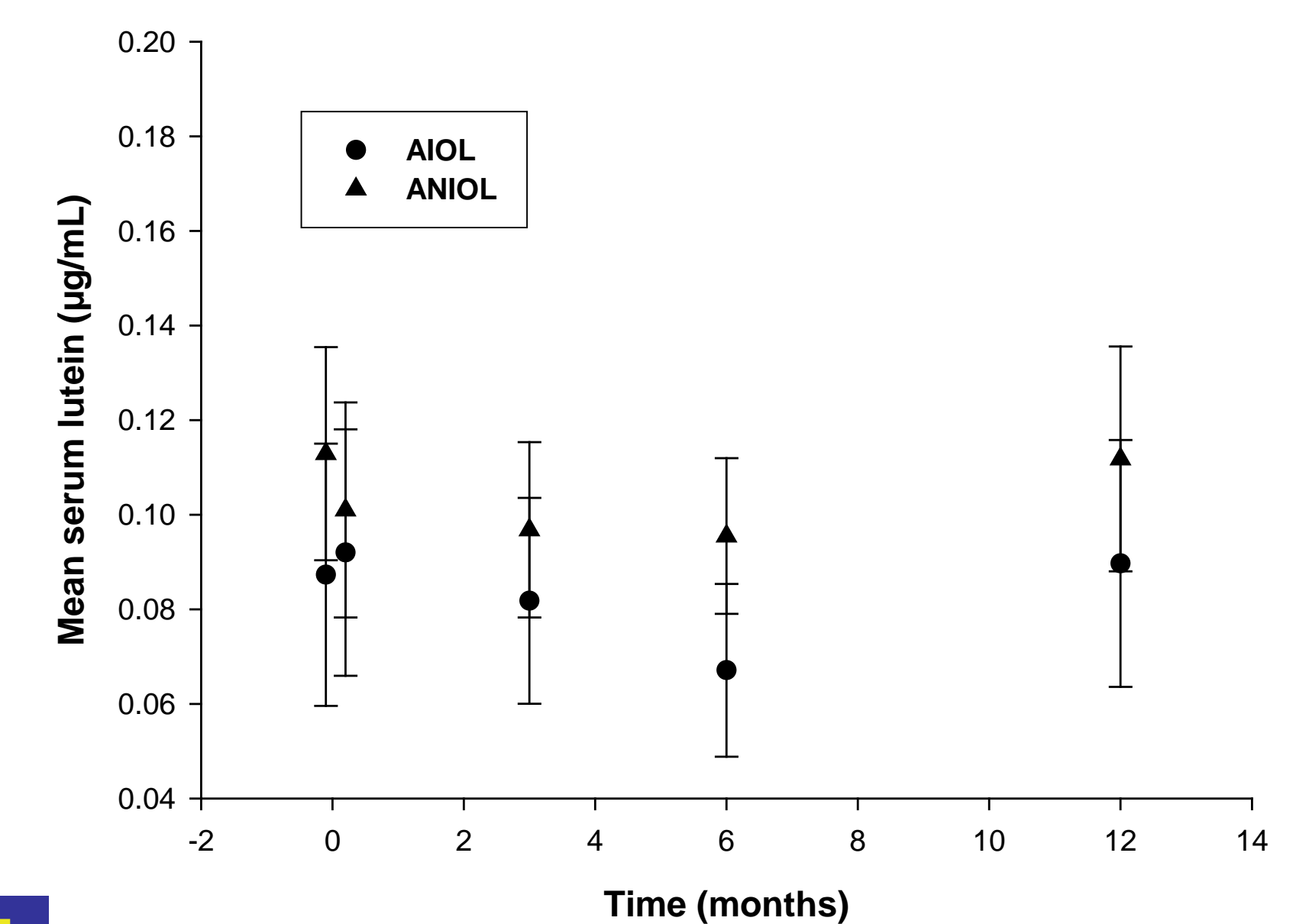
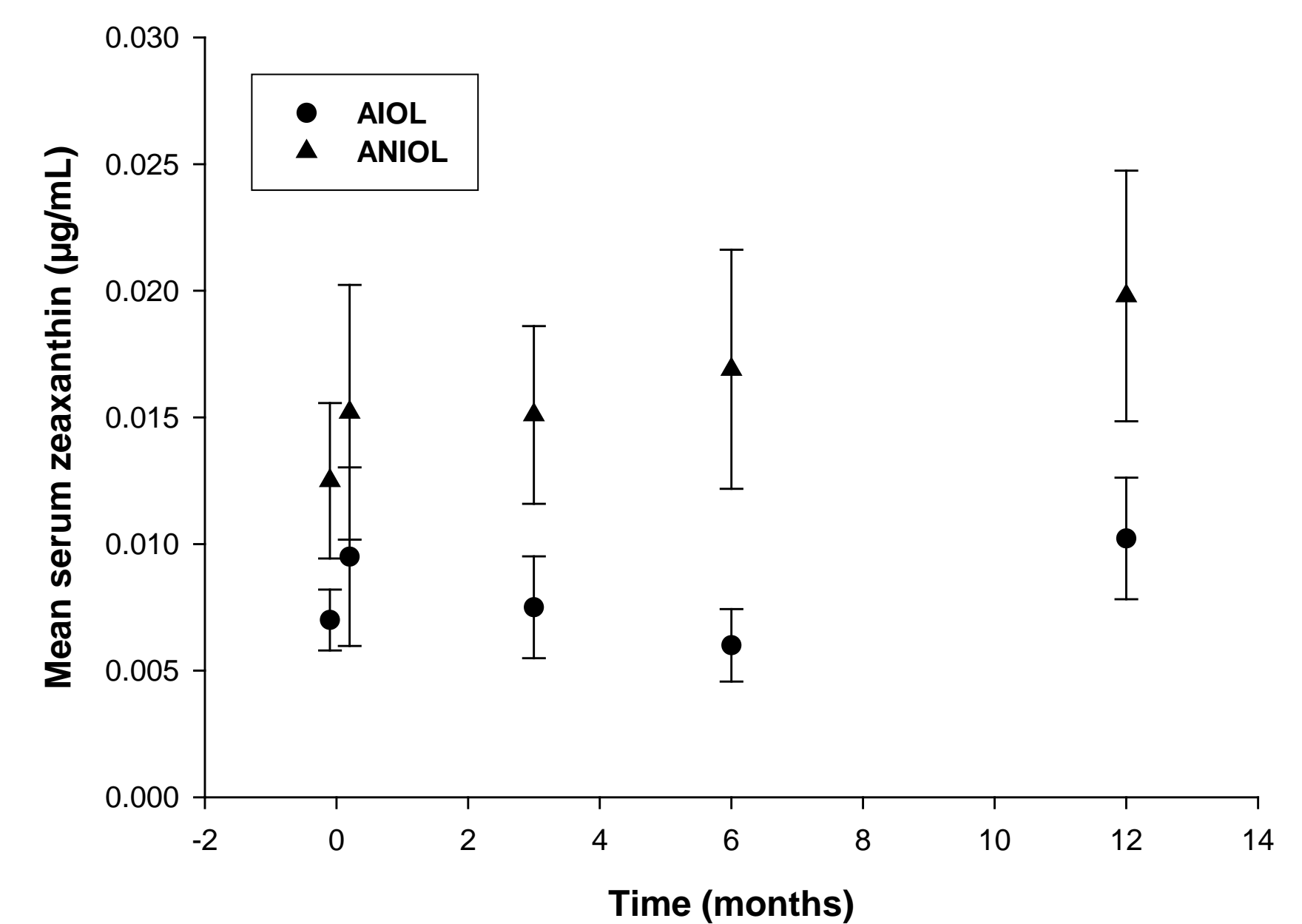


Figure 5.



CONCLUSION

In conclusion, this study provides evidence that implanting an IOL that filters blue light (ANIOL) results in augmentation of MPOD. The importance of this finding rests on the fact that any benefits associated with augmentation of MPOD, in terms of AMD prevention or progression (yet to be proven), will be conferred on patients implanted with an ANIOL at the time of cataract surgery, and may be of particular importance in the modern era where IOL implantation often occurs at an earlier stage in a patient's lifetime (such as in paediatric cataract surgery, refractive lens exchange and relatively early lens opacity in patients with a long post operative life expectancy). However, further study is required in the form of controlled long-term trials to investigate whether implantation of a blue-light filtering IOL is effective in preventing or delaying AMD development or progression.