

Does the high modulus of silicone hydrogel affect the accuracy of tonometry taken directly over the lens?

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Introduction

Several authors (1-5) have reported that it is possible to measure the intraocular pressure (IOP), by different types of tonometers, over a soft hydrogel (Hy) contact lens (CL).

This procedure could be useful for several reasons:

-avoid the topical anaesthesia (because it could likely provoke epithelial erosion or because it is not usable by non-medical practitioners in several countries);

-avoid traumatising in conditions of corneal pathology such as bullous keratopathy, abrasions, ulcers etc. or whenever there is the need of undergoing this exam (tonography) several times;

-when the corneal surface is extremely irregular.

-in order to allow IOP measurement in continuous wear (refractive or therapeutic) without removing CL.

However the measure obtained with this procedure can be affected by water content, design, power and central thickness of the lens. It has been showed that it's possible to control the problem by using a daily disposable soft CL of low negative back vertex power (BVP). In this way you obtain a practical, inexpensive, safe and accurate method (6).

Silicone hydrogel (SH) CLs are now being more frequently used both for refractive and therapeutic purposes for daily and continuous wear.

SH lens materials are significantly "stiffer" than conventional Hy counterparts, due to the incorporation of silicone. The modulus of some SH material is some six times greater than Hy. The mechanical propriety of the high modulus materials could make the procedure of tonometry, effected directly on the lens, inaccurate since they would be less able to conform easily to the shape of the cornea.

Purpose

The aim of this work was to compare the measure of IOP over the SH CL with the highest modulus available in the market versus a daily disposable Hy CL that has been previously shown suitable for this purpose (6).

Methods

Twenty-four healthy subjects (13 males and 11 females; average age 40.4 years, SD 13.4) were enrolled, on voluntary basis, in a single private practice. A Goldmann applanation tonometer was used. In order to reduce observer bias, only one investigator (FZ), experienced in tonometry, made all the measurements. The values were read and recorded by another investigator (LZ). Two measurements were taken for each eye of each subject. One with a sph -1.50D lotrafilcon A CL (Air Optix™ Night and Day®), Ciba Vision) and the other one with a sph-1.50D hialifilcon A CL (SofLens® one day, Bausch & Lomb), for a total of 48 eyes. CL properties are reported in Tab.1.

In order to prevent the possible effect of "repeated measurement" following Motolko (7), the sequence of the two measurements over the two CLs was always inverted in the two eyes of the same subject.

Lens Type	lotrafilcon A (Air Optix™ Night & Day®)	hialifilcon A (SofLens® one day)
BOZR (mm)	8.40	8.60
TD (mm)	13.8	14.2
Modulus (Mpa)	1.52	0.24
Dk (Barrel) x 10 ⁻¹³	140	33
Water content (H ₂ O %)	24	70
t _c (0~3.00D) (mm)	0.08	0.17
FDA Group	I	II

Tab.1: Properties of the two CLs used in the experiment.

After fitting one CL the edge of a previously moistened fluorescein strip was lightly applied to the upper bulbar conjunctiva. Topical anaesthesia was not used. For each measurement three consecutive readings were taken and the average was accepted as the final value. The drum was reset to 10 mmHg after each reading.

Results

There is a good correlation between the IOP measures over lotrafilcon A and over hialifilcon A ($r=0.75$; $p<0.05$). Fig.1 reports regression analysis: slope was 0.79 and intercept was 2.94. The Bland Altman plot (Fig.2) shows that almost the plots are within 2 SD, moreover no significant trend was detected for differences between the two measures of IOP as a function of their mean value. A paired Student's test comparing the IOP over lotrafilcon A and the IOP over hialifilcon A showed no statistical difference ($t=0.46$ $p=0.64$). None of participants has reported pain or discomfort during the tonometry, according to previous findings (6).

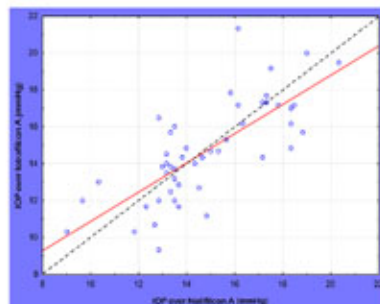


Fig.1: Correlation graph comparing the IOP over lotrafilcon A and the IOP over hialifilcon A. Dashed line indicates the equality line.

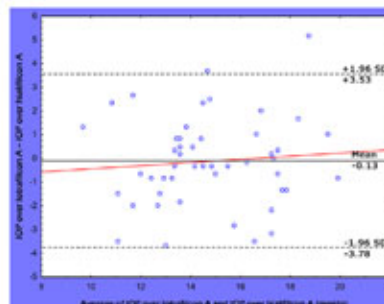


Fig.2: Bland Altman plot. Dashed lines represent the 95% confident intervals for the differences.



Fig.3: The tonometer head is in contact with the lotrafilcon A CL. Two semicircles appear at the observer after fluorescein dropping.



Fig.4: The tonometer head is in contact with the hialifilcon A CL. In this case two full semicircles appear at the observer because the Hy absorbs completely fluorescein.

Discussion

In the present study it has been found that IOP measurement by Goldmann applanation tonometry over the highest modulus SH CL is not significantly different compared to the one obtained over an Hy CL. Furthermore such procedure is safe in terms of sensation without the use of topical anaesthesia as it was previously described using daily disposable Hy CL (6).

Allen et al. (8) compared the IOP values taken over a SH CL respect to the ones obtained without CL in a quite small group (10 Ss) where the sequence of the two measurements was not randomized. Topical anaesthesia was used for every measurement. Our results agree with this study although the SH CL chosen in our study is different for water content, central thickness, BVP and, mainly, in modulus being lotrafilcon A quite higher respect to balafilcon A (1.10 Mpa).

Our results have been obtained using only one BVP (sph -1.50D) and for a limited range of IOPs between 10 and 20 mmHg. Positive and negative higher powers SH CLs, being stiffer, could affect the accuracy of the measure. Further investigation is needed for different BVPs and for IOP range different from the normal.

Another aspect of the procedure is that the tonometric image seen during the tonometry is little different with the two CLs. The lotrafilcon A absorbs very low quantity of fluorescein so the aspect (two empty semicircles) is similar to the conventional one (Fig. 3). Instead, a double image of two full semicircles appears to the observer with Hy CL because it is fully stained by fluorescein (Fig. 4).

Conclusions

There is no significant difference in IOP measured over a lotrafilcon A CL, having the highest modulus, compared to the one measured over low modulus Hy CL. This is true for a normal range of IOP (our sample was comprised between 10 mmHg and 20 mmHg) and for a sph -1.50 D. Further studies are needed to verify if similar findings occur in case of positive or higher negative CL powers and for higher IOP range.

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