THE ADSORPTION OF MAJOR TEAR FILM LIPIDS in vitro TO VARIOUS SILICONE HYDROGELS OVER TIME

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Abstract

Purposes: Lipid fouling is a prevalent issue with silicone hydrogel materials, a novel in vitro study was conducted to measure the adsorption of major tear film lipids over time. This study may give clear insight into the rate of accumulation of both polar and non-polar lipids during the wear of silicone hydrogel soft contact lenses.

Methods: Commercial balafilcon A (PureVision®), galyfilcon A (Acuvue® Advance™), lotrafilcon A and B (Night & Day® and O2Optix™) and senofilcon A (Acuvue® Oasys™) were all soaked for 14 hours in the dark at 34.5°C in 1x phosphate buffered saline (PBS) pH 7.4. After washing 3 times in PBS, each lens was incubated with 1 mL of either PE or cholesterol, both of which were tagged with fluorescent labels. All solutions were made up in phosphate buffered saline (PBS) at pH 7.2. The lenses were then washed 3 times in PBS. The solution was then placed into the well of a 24-well plate, and the absorbance was measured every 5 to 7 days. The lenses were then placed into a 24-well plate individual lipid being tested and the protocol was repeated for 20 days.

Results: In vitro adsorption of cholesterol was greater for all lens types compared to PE. After 20 days soaking in PE, senofilcon A and balafilcon A showed the lowest adsorption of 4.4 and 5.5 µg/lens respectively. Galafilcon A and senofilcon A showed significantly higher in vitro PE adsorption at 5.1 and 4.5 µg/lens respectively. Balafilcon A adsorbed 3.2 µg/lens. Sensofilcon A and balafilcon A had the highest in vitro affinity for cholesterol compared to all other lens types after 20 days, with adsorptions of 23.2 and 24.4 µg/lens respectively. Lotrafilcon B showed the lowest in vitro adsorption of cholesterol at 9.9 µg/lens, in agreement of both polar and non-polar lipids appeared to reach saturation with galyfilcon A at approximately 12-14. In vitro adsorption for lotrafilcon A and B plateaued at approximately day 17. For balafilcon, in vitro adsorption of PE occurred by day 14, whereas saturation was not complete with cholesterol by day 20.

Conclusions: In vitro lipid adsorption was significantly greater upon the lens material for both polar and non-polar lipids. Balafilcon A had the lowest adsorption of lipid in the test and is it because it is any of the other silicone hydrogel polymers tested.

Introduction

Spillage of contact lenses by either proteins or lipids is an important factor in the overall comfort associated with the wear of silicone hydrogel soft contact lenses.

Purposes: Lipid fouling is a prevalent issue with silicone hydrogel materials, a novel in vitro study was conducted to measure the adsorption of major tear film lipids over time. This study may give clear insight into the rate of accumulation of both polar and non-polar lipids during the wear of silicone hydrogel soft contact lenses.

Methods: Commercial balafilcon A (PureVision®), galyfilcon A (Acuvue® Advance™), lotrafilcon A and B (Night & Day® and O2Optix™) and senofilcon A (Acuvue® Oasys™) were all soaked for 14 hours in the dark at 34.5°C in either cholesterol (CH3-CH2-CH(2)-COOH, 10µg/mL) or phosphotidylethanolamine (PE, 10µg/mL) solution. Both solutions were tagged with fluorescent labels. All solutions were made up in phosphate buffered saline (PBS) at pH 7.2. The lenses were then washed 3 times in PBS. The solution was then placed into the well of a 24-well plate individual lipid being tested and the protocol was repeated for 20 days.

Results: In vitro adsorption of cholesterol was greater for all lens types compared to PE. After 20 days soaking in PE, senofilcon A and balafilcon A showed the lowest adsorption of 4.4 and 5.5 µg/lens respectively. Galafilcon A and senofilcon A showed significantly higher in vitro PE adsorption at 5.1 and 4.5 µg/lens respectively. Balafilcon A adsorbed 3.2 µg/lens. Sensofilcon A and balafilcon A had the highest in vitro affinity for cholesterol compared to all other lens types after 20 days, with adsorptions of 23.2 and 24.4 µg/lens respectively. Lotrafilcon B showed the lowest in vitro adsorption of cholesterol at 9.9 µg/lens, in agreement of both polar and non-polar lipids appeared to reach saturation with galyfilcon A at approximately 12-14. In vitro adsorption for lotrafilcon A and B plateaued at approximately day 17. For balafilcon, in vitro adsorption of PE occurred by day 14, whereas saturation was not complete with cholesterol by day 20.

Conclusions: In vitro lipid adsorption was significantly greater upon the lens material for both polar and non-polar lipids. Balafilcon A had the lowest adsorption of lipid in the test and is it because it is any of the other silicone hydrogel polymers tested.

Materials and Methods

Methods

Standard curve

- A separate standard curve was developed for each lens type assayed.
- PE and cholesterol standards were made up in duplicate in phosphate buffered saline over a concentration range of 0-20 µg/mL.
- 1 mL of standard at each concentration was placed in the well of a 24-well plate (Costar 3473) in duplicate.
- An appropriate lens was also placed in each well of the standard curve plate to correct for any auto fluorescence by the lens material.
- The plate was then wrapped in foil and incubated along with the samples at 34.5°C with rocking.
- The standard curve plate was removed from the incubator each day and read on the Wallac Victor II 1420 multilabel fluorescence counter, along with the samples.

Samples

- Five lenses for each type were placed in a 24-well plate (Costar 3473) and soaked for 14 hours in 1 mL of a physiological concentration of either 0.2 µg/mL PE (FITC, Molecular Probes) or 1.75 µg/mL of cholesterol (CH3-NBD, AVANTI).
- All solutions were made up in 1x phosphate buffered saline (PBS) at pH 7.2.
- Control lenses were soaked in 1 mL of PBS for 14 hours.
- Lenses were incubated at 34.5°C in the dark with rocking.
- The lenses were then washed three times in 1 mL of PBS and placed in a fresh 24-well plate with 1 mL of PBS.
- The lenses were then read on a Wallac Victor II 1420 multilabel counter at a wavelength of 465 nm.
- A fresh solution of either PE or cholesterol was then placed on the lenses and incubated as described above.
- This was repeated for 20 days and all results were calculated as µg/lens from the standard curve read that day.

Figure 1:

The adsorption of phosphotidylethanolamine by various silicone hydrogel lenses over 20 days of exposure to concentrations of this lipid comparable to those found in the tear film.

Figure 2:

The adsorption of cholesterol by various silicone hydrogel lenses over 20 days of exposure to concentrations of this lipid comparable to those found in the tear film.

Figure 1 and 2. The adsorption of major tear film lipids by various silicone hydrogel contact lenses.

Discussion/Conclusions

The higher in vitro adsorption of cholesterol indicates that hydrophobic interactions play a greater role in adsorption of lipids than that of charge.

If hydrophobicity is inadequate to be the driving force in lipid adsorption for silicone hydrogels, it may be inferred that the lotrafilcon lenses are more hydrophobic than galafilcon A, sensofilcon A and balafilcon A.

This study reflects the affinity of various materials to two distinct lipid species.

References