Kinetics of *In Vitro* Lysozyme Deposition on Silicone Hydrogel, FDA Group II and FDA Group IV Contact Lens Materials

Lakshman N Subbaraman, Mary-Ann Glasier, Michelle Senchyna, Lyndon Jones

Centre for Contact Lens Research, School of Optometry, University of Waterloo, Ontario, Canada

Introduction

- Following insertion onto the eye, hydrogel contact lenses rapidly adsorb components from the tear film, particularly protein, lipid, and mucin.[1-3] These deposits create a number of problems for patients, including discomfort, reduced visual acuity, dryness and reduced lens life.[4]
- Protein deposits may be more problematic as they can lead to adverse immunological responses, including giant papillary conjunctivitis.[5] Lysozyme is a protein which is predominantly found on FDA group IV contact lens materials and is therefore often used as the prototypical marker for protein accumulation.[6,7]
- Several studies have investigated the kinetics of protein or lipid deposition on contact lens materials *in vivo*,[7,8] and *in vitro* [9,10] on conventional hydrogel lens materials. Although, the quantity and/or conformation of lysozyme deposited on silicone hydrogel (SH) lens materials have been reported,[11,12] to-date, no study has investigated the deposition of lysozyme as a function of time in SH lens materials.
- Knowing the rate of protein deposit accumulation and the duration at which accumulation reaches either a maximum or a plateau level could be clinically relevant to patient symptoms and be helpful in designing clinical investigations of hydrogel lenses and associated lens care products, in addition to determining the most appropriate replacement frequency.

Purpose

The purpose of this study was to gain insight into the kinetics of lysozyme deposition on SH lenses and compare this data with the results from FDA group II and FDA group IV conventional hydrogel lens materials using an *in vitro* radiolabelling method.

Materials & Methods

Table 1: Characteristics of conventional hydrogel lens materials evaluated in this study.

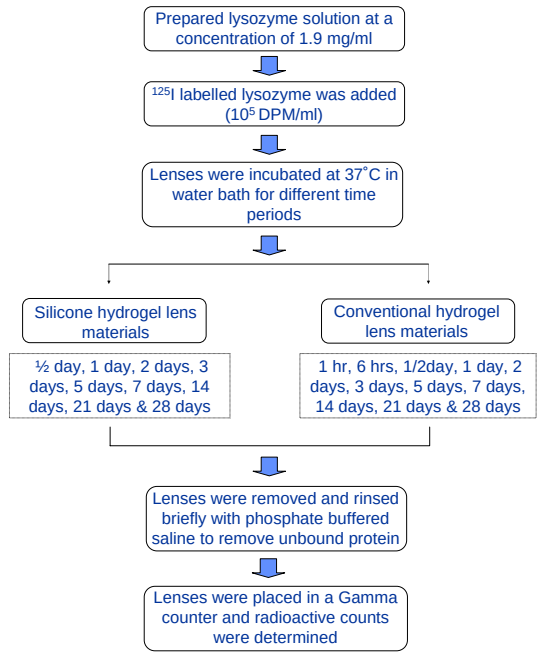
	Acuvue	SofLens 66
Manufacturer	Vistakon	Bausch & Lomb
USAN	Etafilcon A	Alphafilcon A
FDA Group	IV	II
Water Content	58%	66%
Monomers	HEMA/ MA	HEMA/ NVP

HEMA, poly(2-hydroxyethyl methacrylate); MA, methacrylic acid; NVP, N-vinyl pyrrolidone.

Table 2: Characteristics of silicone hydrogel lens materials evaluated in this study.

	Focus Night & Day	O_2 Optix	PureVision	Acuvue Advance
Manufacturer	CIBA Vision	CIBA Vision	B & L	Vistakon
USAN	lotrafilcon A	lotrafilcon B	balafilcon A	galyfilcon A
FDA Group	I	I	III	I
Water content	24%	33%	36%	47%
Dk	140	110	99	60
CT –3.00D	0.08	0.08	0.09	0.07
Dk/t	175	138	110	86

Figure 1: Schematic of protocol adopted to determine the kinetics of lysozyme deposition on different contact lens materials.



Results

Figure 2: Kinetics of lysozyme deposition on group II lens material.

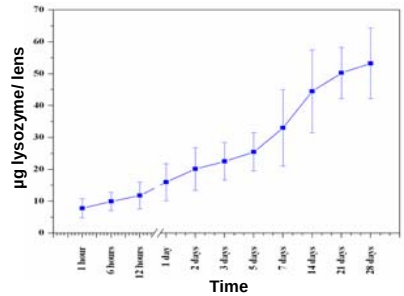


Figure 3: Kinetics of lysozyme deposition on group IV lens material.

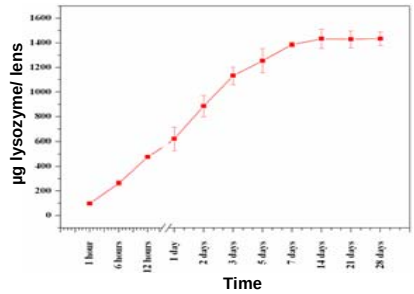
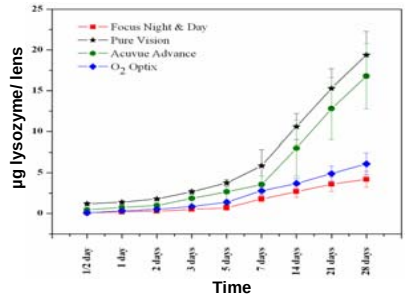


Figure 4: Kinetics of lysozyme deposition on silicone hydrogel lens materials.



- The etafilcon material deposited significantly more lysozyme than all other lens materials ($p<0.001$) and the amount of lysozyme increased significantly between days 1 and 7 ($p<0.001$) and then reached a plateau, with no further increase occurring ($p>0.05$).
- The group II and SH lens materials exhibited a significant increase in lysozyme deposition across all time points ($p<0.001$).
- **SH lens materials:** There were no significant differences between the four lens materials until 3 days ($p>0.05$). There were significant differences in lysozyme deposition between lotrafilcon A versus balafilcon lenses ($p<0.001$) and lotrafilcon A versus galyfilcon lenses ($p<0.001$) across all time periods after 5 days. However, there were no significant differences between lotrafilcon A and lotrafilcon B lens materials across all time points ($p>0.05$). There were significant differences between lotrafilcon B Vs. galyfilcon ($p<0.001$) at two weeks and lotrafilcon A Vs. balafilcon ($p<0.001$) at four weeks.

Conclusions

- Radiolabelling is a sensitive and reproducible technique to determine small quantities of lysozyme deposited on contact lens materials.
- Lysozyme deposition occurs rapidly with FDA group IV materials before reaching a maximum, while SH and FDA group II materials progressively accumulate lysozyme, with no plateau occurring.
- These results reiterate that silicone hydrogel lens materials deposit very low quantities of lysozyme, when compared to conventional hydrogel lens materials.
- Kinetics of lysozyme deposition on contact lenses depends upon the chemical structure of the lens material under consideration.

References

1. Bontempo AR, Rapp J. *CLAO J* 2001;27(2):75-80.
2. Castillo EJ *et al. Biomaterials* 1986;7(1):9-16.
3. Jones L *et al. CLAO J* 1997;23:122-6.
4. Gellatly K *et al. Am J Optom Physiol Opt* 1988;65(12):937-41.
5. Porazinski AD, Donshik PC. *CLAO J* 1999;25:142-7.
6. Sack R *et al. Invest Ophthalmol Vis Sci* 1987;28(5):842-9.
7. Keith DJ *et al. Eye Contact Lens* 2003; 29: 79-82.
8. Jones L *et al. Optom Vis Sci* 2000; 77: 503-10.
9. Garrett Q *et al. Invest Ophthalmol Vis Sci* 1999; 40: 897-903.
10. Baines MG *et al. Optom Vis Sci* 1990; 67: 807-10.
11. Jones L *et al. Eye Contact Lens* 2003 (suppl); 29(1): s75-9.
12. Senchyna M *et al. Curr Eye Res* 2004; 28(1):25-36.

Acknowledgements

This work was funded by a Collaborative Research and Development Grant from NSERC Canada and Alcon Research Limited. The authors wish to acknowledge Dr Heather Sheardown (McMaster University).