TEAR LIPID PROFILES ON SOFT CONTACT LENSES

Fiona J. Lydon, Val Franklin, and Brian Tighe

Aston Biomaterials Research Unit, Aston University, Birmingham, UK

Abstract

PURPOSE. The interaction of lipoidal species with surface and matrix of soft contact lens materials is important in the development of spoilation resistant contact lenses and successful ocular prostheses. Lipids are highly reactive molecules, which interact with the surface of a contact lens and are also readily absorbed into the lens matrix. Once in the lens matrix these species are no longer in close contact with the antioxidants in the superficial tear layer and may alter their chemical structure. These altered lipoidal species are less readily desorbed from the lens matrix and may provide a site for further deposition to occur. The aim of this study was to profile the type of extractable lipids from daily disposable and thirty night continuous wear contact lenses.

METHOD. A number of contact lenses, which had been worn on a daily wear basis or for thirty nights continuously, were collected. The gross levels of lipids were assessed using fluorescence spectrophotofluorimetry on collection and after extraction of the lipids for further analysis. The lipid profiles were determined using high performance liquid chromatography.

RESULTS. The lipid patterns for both the surface deposition and extractable lipid profiles were variable between patients. Patient-based effects outweighed those related to wear time. The type of lens material also played a role in the type of lipid laid down on the lens.

CONCLUSIONS. Variations in patient lipid deposition profiles are known to be greater than protein deposition patterns. Although wear period is a progressive driver of deposition it is outweighed by materials dependence and patient to patient variation. Wear time becomes an important issue for the small but significant number of heavy lipid spoilers. There is a need to match the patient to the lens type and wear schedule in order to minimise these problems.

Materials

A number of different types of contact lenses, which had been worn either on a daily disposable, conventional daily wear basis or for thirty nights continuously, were collected. Details of the lenses are given in Table 1.

Table 1 :- Lenses Assessed During This Study

Lens Type	Wear Period	USAN	EWC [%]	Care system	Number of lenses	Monomer
1-Day Acuvue*	1 day	Etafilcon A	58	N/A	5	HEMA, MA
Focus Dailies*	1 day	Nelfilcon A	69	N/A	5	PVA
Soflens One Day*	1 day	Hilafilcon A	70	N/A	5	HEMA, VP
Precision UV^	4/52	Vasurfilcon A	74	Miraflow + 10:10	5	MMA, VP
Omniflex^	104/52	Lidofilcon A	70	Miraflow + 10:10	5	MMA, VP
ES70^	26/52	-	70	Miraflow + 10:10	5	MMA, VP
Medalist 66	4/52	Alphafilcon A	66	ReNu	5	HEMA, VP
Acuvue	2/52	Etafilcon A	58	ReNu	5	HEMA, MA
Focus Night & Day	4/52	Lotrafilcon A	24	N/A	5	
Purevision	4/52	Balafilcon A	36	N/A	5	

* These lenses were worn by the same patient on a crossover basis, who is a heavy lipid spoiler.
^These lenses had calcuim present.
Abbreviation key for monomers:- MMA = methyl methacrylate, HEMA = 2-hydroxyethyl methacrylate, VP = N-vinyl pyrrolidone, MA = methacrylic acid, PVA = polyvinyl alcohol.

Methods

Gross Lipid Levels Assessment using fluorescence spectrophotofluorimetry

The lipid spoilation profiles were assessed using a specially modified Hitachi F4500. This is a non-destructive technique that relies on the low-level fluorescence/luminescence of lipoidal species following excitation by UV light. The lipid was assessed using an excitation wavelength of 280nm (aqueous soluble) and 360nm (aqueous insoluble). Baseline fluorescence for each lens materials was evaluated by examining a blank, unworn lens as described above. This background trace was then subtracted from the result achieved with each worn lens to assess accurately the degree of deposited material. The lipid levels were assessed on collection and after extraction of the lipids for further analysis.

High Performance Liquid Chromatography

The lipids are extracted from the contact lens using methanol, which is then evaporated off by bubbling nitrogen over the surface of the solvent. The resulting lipid extracts are then analysed by high performance liquid chromatography (HPLC) after dissolution in the mobile phase.

The HPLC system used is a Knauer high pressure liquid chromatograph equipped with a Rheodyne 7125 injector and a Lichrosorb 5µm (250mm X 4mm ID) SI 60 normal phase column used in conjunction with a mobile phase of hexane:propan-2-ol:acetic acid (1000:5:0.5 v/v). The eluent was detected using a Perkin-Elmer LC-75 UV detector and Perkin-Elmer Filter Fluorescence detector in series. The system is run and data collected by a PC.

Results

The surface lipid deposition was assessed using fluorescence spectrophotofluorimetry and the lipid levels varied between patients. The lipid levels for the lenses prior to extraction and after extraction assessed using excitation wavelengths of 280nm and 360nm are shown in Figures 1 and 2 respectively. These figures show the lipid levels deposited on the different lenses vary both after wear and after extraction of the less strongly bound lipid. A decrease in the fluorescence signal of the lipid is observed after extraction of lipid from the lenses but some lipid more strongly bound lipid remains within the lens matrix..

Figure 1: Histogram showing the Lipid Levels Before and After Extraction using an Excitation Wavelength of 280nm

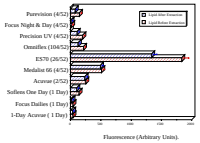
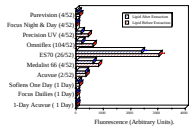


Figure 2: Histogram showing the Lipid Levels Before and After Extraction using an Excitation Wavelength of 360nm



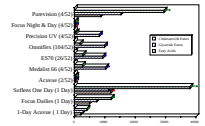
Results

An example of a chromatogram for the extractable lipid is shown in Figure 3. These lipid fingerprints show variations in the quantity of the lipid types between patients and lens types. This is shown in Figure 4 which summaries the quantities, in terms of peak area, for cholesterol and its esters, glyceride esters and fatty acids. The pattern of these classes is similar for all the lenses and demonstrates the role of the superficial or meibomian gland lipids. This figure also shows that the quantities of the lipid classes extracted from the lens depend on the type of lens material, as certain monomers absorb lipid more strongly than others, and patient lipid spoilation levels vary.

The longer wear periods did not necessarily increase the quantity of lipid deposited when the lenses were worn on a conventional daily wear basis or continuously. Lipid deposited onto conventional wear lenses increases during wear but is then reduced by cleaning prior to a further build-up during the following days wear. Not all of the lipid is removed by lens cleaning.

Figure 3: An Example of a Chromatogram.

Figure 4: - Histogram showing the Relative HPLC Peak Areas of the Extracted Lipid Classes



Conclusions

Variations in patient lipid deposition are known to be greater than protein deposition. This study demonstrates the following points about lipid spoilation:

- The lipid deposition varies for different types of lenses due to the role that the lens composition plays in lipid absorption.
- Not all of the lipid can be extracted from the contact lenses after wear regardless of the wear schedule or if a cleaning regime is used.
- The same lipid classes are obtained by extraction of deposited lipid from the lens, but there is variation in the quantities of these classes.

Longer wear periods did not necessarily increase the quantity of lipid deposited when the lenses were worn on a conventional daily wear basis or continuously.