Contact Lens & Anterior Eye 37 (2014) 351–357

Contents lists available at ScienceDirect

Contact Lens & Anterior Eye

journal homepage: www.elsevier.com/locate/clae

An acute clinical comparison of corneal staining and comfort associated with contact lens care solutions☆

Florence Malet*

CHU Bordeaux, Hôpital Pellegrin, Département d'Ophtalmologie, Bordeaux, France

ARTICLE INFO

Article history:
Received 15 July 2013
Received in revised form 24 April 2014
Accepted 19 May 2014

Keywords:
Contact lens care solution
Corneal staining
Fluorescein
Polyhexamethylene biguanide
Solution-induced corneal staining

ABSTRACT

Purpose: This study compared the biocompatibility and comfort of 4 lens care solutions currently marketed in France.
Methods: This was a randomized, interventional, double-masked, single-center crossover study assessing balafilcon A silicone hydrogel contact lenses, bilaterally, straight from the blister pack solution (control) and pre-soaked in the following lens care solutions: Regard® (containing sodium chlorite), ReNu® (containing a PHMB [polyhexamethylene biguanide] derivative), CyClean™ and MeniCare™ Soft (both containing PHMB). Subjects were randomized to the order of test solution use. For each of the 5 solutions tested, subjects attended a baseline/lens dispensing visit and an intervention visit 2 h later. At both visits, evaluation included slit-lamp examination, corrected-distance visual acuity, corneal staining, and subject-assessed photophobia, ocular comfort, and ocular redness.
Results: Thirty subjects were enrolled and 28 were evaluable. Corneal staining severity was significantly worse than baseline after 2 h of wearing lenses soaked in CyClean, MeniCare, or ReNu ($P \leq 0.001$). The MeniCare group alone demonstrated a significant improvement in ocular comfort after 2 h of lens wear ($P = 0.02$). No group demonstrated significant changes in ocular redness or photophobia. Corrected-distance visual acuity was similar between baseline and intervention visits for each test solution. No adverse events were reported during the study.
Conclusions: Silicone hydrogel contact lenses presoaked in lens solutions containing PHMB or a PHMB derivative produced an increase in corneal staining after 2 h of lens wear. The higher levels of corneal staining in the 2 solutions did not correlate with increased discomfort within this 2-h timeframe.

1. Introduction

It is well documented that various contact lens disinfecting solutions used in combination with silicone hydrogel or traditional hydrogel contact lenses frequently induce a characteristic corneal epithelial cell response that can be viewed with sodium fluorescein staining [1]. This solution-induced corneal staining (SICS) is a transient phenomenon in which a characteristic punctate staining pattern is typically present in at least 4 of the 5 corneal regions [2].

Solution-induced corneal staining is most evident from 1 to 4 h after contact lens insertion [3–5] and generally returns to baseline after 6 h [5]. Although some reports of SICS indicate that it presents as low-grade staining without any associated symptoms, other evidence suggests that SICS may negatively impact ocular comfort [3,6,7]. This potential relationship between SICS and comfort is important because contact lens discomfort is a primary reason for discontinuation of contact lens wear [8,9].

Solution-induced corneal staining appears to be dependent upon the interaction between the contact lens material and components of the contact lens solution [3,10,11]. This phenomenon may be caused by the release of solution components that have soaked into the lenses or possibly by changes in the chemical composition of the lens surface resulting from exposure to the lens care solution [7,12–14]. Several studies have demonstrated that corneal staining varies greatly among lens material/contact lens solution combinations [5,15]. While the greatest extent of SICS reported involved the use of certain biguanide-containing solutions (polyhexamethylene biguanide [PHMB] and polyaminopropyl biguanide [PAPB, a PHMB derivative]) [3,5,16], it should be noted that the disinfecting agent is not solely responsible for staining, as staining is also impacted by other constituents in the lens care formulation [17].

Although previous studies have used corneal staining to evaluate the biocompatibility of numerous FDA-approved soft contact

☆ ClinicalTrials.gov identifier: NCT00929487.

* Correspondence to: CHU Bordeaux – Hôpital Pellegrin, Département d'Ophtalmologie, Place Amélie Raba Léon, 33076 Bordeaux, France.
Tel.: +33 5 56 79 56 08; fax: +33 5 56 79 59 09.
E-mail address: Florence.malet@chu-bordeaux.fr

http://dx.doi.org/10.1016/j.clae.2014.05.007
1367-0484/

lens solutions for the U.S. market [3,5,18,19], none of the studies conducted in Europe [20–23] assess the biocompatibility of the various contact lens solutions marketed in France. The aim of this study was to compare the biocompatibility and comfort of a range of currently marketed lens care solutions commonly available in France.

2. Methods

The primary objective of this study was to compare the biocompatibility of 4 contact lens care solutions and 1 control blister-pack solution, in conjunction with a silicone hydrogel soft contact lens by assessing corneal staining. The secondary objective was to compare the subject-reported comfort of these contact lens solutions after 2 h of wear.

2.1. Study design

This was a randomized, interventional, double-masked, single-center crossover study assessing four different contact lens care solutions: CyClean™ (Sauflon Pharmaceutical, Twickenham, England), MeniCare™ Soft (Menicon Co. Ltd., Nagoya, Japan), ReNu® Multipurpose Solution Original (Bausch & Lomb Incorporated, Kingston-upon-Thames, UK), and Regard® (Vita Research, Ariccia, Italy), as well as a control blister packaging solution (unpreserved sterile saline), each used with silicone hydrogel contact lenses made from balafilcon A (PureVision® [Bausch & Lomb Incorporated]). According to their packaging materials, the 4 contact lens care solutions contain the following disinfection ingredients: CyClean, PHMB and Biopol™; MeniCare Soft, PHMB; ReNu, PAPB; and Regard, OxyChlorite™ (sodium chlorite). Thirty subjects, recruited from a single site in France, were randomized to the order of use of the test contact lens care solutions or control blister solution. For each of the 4 test solutions and the control solution, subjects attended a visit for baseline assessment and dispensing and an intervention visit for follow-up assessment, which was held 2 h after the first visit. There was a wash-out period of one night prior to dispensing. The protocol was approved by an ethical committee (Bordeaux University Hospital ethical committee) and the study was performed in compliance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice. All participating subjects provided written informed consent prior to the start of the study.

At the screening/enrollment visit, the investigator assessed subject eligibility, including visual acuity, keratometry, and slit-lamp biomicroscopy. Eligible subjects (soft contact lens wearers with corrected-distance visual acuity of 0.2 log MAR or better, who were at least 18 years of age, not pregnant or lactating, not using ocular medications and not afflicted by ocular disease or issues that would confound the study results – see Table 1) were enrolled and assigned randomization. The investigator recorded subject demographic information and baseline characteristics, including age, gender, habitual lenses, and habitual lens care solution. Subjects were asked to avoid wearing contact lenses for at least 12 h prior to each baseline assessment visit. Exclusion criteria are listed in Table 1. At each of the 5 baseline/dispensing visits, the investigator recorded baseline subjective photophobia assessment, performed slit-lamp examination, and performed corneal staining assessment. For subjects who were eligible to continue the study, contact lenses that had been presoaked in test solution for at least 10 h (except for the control blister packaging solution, which required no lens presoaking) were inserted bilaterally. Between 15 and 30 min after insertion, the investigator assessed lens centration, post-blink movement, and overall fit acceptance. Subjects with satisfactory lens fitting then completed the baseline subjective ocular comfort assessment using a visual analog scale and a baseline subjective ocular redness assessment. While subjects wore the study contact lenses, the investigator assessed corrected-distance visual acuity (CDVA).

Table 1
Inclusion and exclusion criteria for the study.

Administrative and demographic requirements: subjects
- were required to provide informed consent prior to screening;
- were required to be at least 18 years of age;
- could be of either gender, any race, and have any occupation and reason for contact lens wear;
- could not be a relative of the investigator or a member of the investigator's office staff or household; and
- could not be pregnant, lactating, or planning a pregnancy.

Ocular requirements: subjects were required to have
- successfully worn hydrogel contact lenses on a daily basis for at least 2 weeks prior to the study;
- corrected-distance visual acuity of 0.20 log MAR or better in each eye while wearing hydrogel contact lenses; and
- normal eyes (clear cornea, no anterior segment disorder, no clinically significant slit-lamp findings, and no other active ocular disease or recent surgery).

Exclusion criteria: subjects could not have
- history of
  - hypersensitivity to any components of the study contact lens solutions; or
  - seasonal allergies with significant ocular side effects that could have an adverse effect on contact lens wear (oral antihistamines were acceptable if the condition was stable and the subject had been using the treatment for at least 30 days prior to the study);
- evidence or history of
  - epithelial herpes simplex keratitis (dendritic keratitis);
  - vaccinia, active or recent varicella, or viral disease of the cornea and/or conjunctiva;
  - acute bacterial disease of the cornea and/or eyelids;
  - mycobacterial infection of the eye; or
  - fungal disease of the eye;
- any present observation of the following, as observed by slit lamp at the baseline visit of each study period
  - type 2 (macropunctate) or greater corneal staining in any region in either eye;
  - sum of the type of corneal staining ≥ 4 across the entire cornea in either eye;
  - corneal staining covering an area $\geq 20\%$ in 1 or more corneal region in either eye;
  - conjunctival injection > grade 1 (trace redness) in either eye (excluding injection due to conjunctival pingueculae); or
  - any finding of an abnormal nature;
- ocular conditions, such as active acute blepharitis, conjunctival infection, or iritis;
- abnormal lenticular opacity in the visual axis of the crystalline lens in either eye;
- only 1 functional eye or use of only 1 contact lens; or
- current use of concomitant topical prescribed or over-the-counter ocular medication.

At each of the 5 intervention visits, which occurred 2 h (±30 min) after each baseline/dispensing visit, subjects completed the subjective ocular comfort and redness assessments and the investigator assessed CDVA, after which subjects removed and discarded the study contact lenses. Subjects then completed the photophobia statement, and the investigator performed slit-lamp examination and corneal staining assessment. After each intervention visit, subjects were scheduled for the next baseline/dispensing visit, until they had completed testing with all 5 test solutions.

2.2. Efficacy and safety assessments

The primary efficacy parameters were the total corneal staining by area and by severity. Secondary efficacy assessment consisted of corneal fluorescein staining, ocular comfort, photophobia, and ocular redness. The investigator instilled fluorescein sodium 0.4 mL (Fluorescein Faure 0.5%; Novartis, Rueil-Malmaison, France) onto