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ABSTRACT

Introduction: Statistics show that over 34 million Americans wear contact lenses and of these, 85% are hydrophilic contact lens wearers. Contact lens wearers comprise of full or part-time wearers. Part-time wearers may be more susceptible to ocular infections because of potential long-term lens storage in contact lens cases. Contamination of contact lens case has been shown to be a common culprit behind contact lens contamination leading to contact lens-related bacterial keratitis and corneal ulcers. In 2006, Ciba developed a new silver impregnated PRO-GUARD[™] contact lens case to minimize contact lens complications due to lens contamination during storage. This study examines the efficacy of this new lens case compared to a traditional polyethylene contact lens case.

Methods: 20 silver-impregnated cases (Sample A) and 20 traditional polyethylene cases (Sample B) were inoculated with P. aeruginosa, Ciba Aquify[®] solution, and a previously worn (harvested from recruited) soft contact lens wearers >18 years of age) silicone hydrogel lens (O_2) Optix). Cases were either incubated for four hours or for one week. There were 10 control samples per case per time period of incubation. After the designated incubation periods, solution from each case was cultured on Cetrimide agar plates. Agar plates were then incubated at 37 degrees Centigrade for 24 hrs to allow time for bacterial growth.

Results: Preliminary data for the four hour incubation period utilized a diluted titer of *P. aeruginosa*, and did not yield microbial growth in either lens cases. Further testing for the one week incubation period utilized a 100% concentration of *P. aeruginosa* and yielded recordable microbial growth. Employing a Two-sample T-test to the growth data, a p-value of 0.023 demonstrated a significant difference between the polyethylene and PRO-GUARD[™] contact lens cases.

Conclusion: This study has demonstrated that the advent of the silverimpregnated PRO-GUARD[™] cases may be one solution to the dilemma of contaminated contact lens cases.

BACKGROUND

- Contact lens wearers are susceptible to contact lens complications including microbial keratitis (MK) and corneal ulcers.
 - P. aeruginosa is one of the most common pathogens recovered from hydrogel contact lens wearers,¹ and it remains the most common cause of MK due to its complex virulent cell make-up² - nearly 60% of contact lens-related cases of MK are attributed to *P. aeruginosa*.³
- Multiple studies share the same confirmation that *P. aeruginosa* remains the most predominant microorganism recovered from contact lens-related corneal ulcers⁴ accounting for the most devastating complications with the poorest outcome in visual acuity.^{1,5,6}

- in the lens case.
- wear.⁸



MATERIALS AND METHODS

- recruited
- Subjects were asked to use soap and water to wash their hands prior to the insertion of a new pair of the Ciba O₂ Optix lens
- Lenses were worn for eight hours before the investigator removed the lenses with non-powdered gloves
- Lenses were not harvested from subjects who had to remove their lenses or instill artificial tears during the eight hour period
- - Each contact lens case (silver impregnated) and (polyethylene) contained the following: 1. 0.9 ml Ciba Aquify[®] solution and 0.1ml *P. aeruginosa* 2. Harvested Ciba O₂Optix Lens
 - Ten silver impregnated cases and ten polyethylene cases were incubated for four hours
 - Ten other silver impregnated cases and polyethylene cases were incubated for one week
 - incubation

THE IMPLICATION OF LONG-TERM CONTACT LENS STORAGE FOR PART-TIME SILICONE HYDROGEL WEARERS: PRO-GUARDTM VERSUS TRADITIONAL POLYETHYLENE CASE

In addition to MK and corneal ulcers, *in vivo* adhesion studies have shown that silicone hydrogel lenses have a higher propensity for bacterial adhesion and colonization.⁷ This may be a result of manual contamination of the lenses along with contamination from bacteria

Studies have concluded that the lens case is the most frequently contaminated contact lens accessory associated with contact lens

As of mid-2006, Ciba Vision released a new antimicrobial contact lens case called PRO-GUARDTM. which has an additive that releases silver ions in the presence of moisture.

Silver has been found to interfere with bacterial DNA, cellular respiration, sulphydryl groups and enzyme conformation rendering it effective in killing bacteria on contact.⁹ Ciba Vision recommends that the PRO-GUARD[™] lens case be used with Aquify[®] multi-purpose disinfecting solution.

Figure 1. Ciba Pro-GuardTM Case vs. Traditional Polyethylene Case

• Ten spherical soft contact lens wearers free of ocular infections and contraindications to contact lens wear (>18 years of age) were

- There were ten control samples per case per time period of

- agar plate
- for 24 hrs
- of *P. aeruginosa*
 - microbial colonies
- Colonies were defined as each discrete circular growth
- Colonies were counted to quantify the amount of growth

RESULTS

Preliminary data after the four hour incubation period yielded no bacterial growth for either the polyethylene or the PRO-GUARD[™] cases (Table 1). A full 100% concentration of *P*. aeruginosa was then used, which yielded microbial growth from both types of lens cases (Table 2).

Employing a Two-sample T-test to this data, a p-value of 0.023 demonstrated a significant difference between the polyethylene and PRO-GUARD[™] contact lens cases.

Table 1.										
Fourth Titer Time Interval	Number of Colonies									
	Plate #1	Plate #2	Plate #3	Plate #4	Plate #5	Plate #6	Plate #7	Plate #8	Plate #9	Plate #10
4 hrs (Polyethylene)	0	0	0	0	0	0	0	0	0	0
4 hrs (Pro-Guard)™	0	0	0	0	0	0	0	0	0	0

FullFullConcentrationTime Interval	Number of Colonies										
	Plate #1	Plate #2	Plate #3	Plate #4	Plate #5	Plate #6	Plate #7	Plate #8	Plate #9	Plate #10	
1 week (Polyethylene)	56	198	175	130	163	170	157	105	138	75	
1 week (Pro-Guard)™	155	70	175	47	64	35	51	59	85	107	

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• A sterile plastic loop was used to transfer samples from each case to a Cetrimide

• Samples from each silver-impregnated, traditional polyethylene and control cases were grown on Cetrimide agar plates and incubated at 37 degrees Centigrade

• Preliminary data for the four hour incubation period utilized a diluted concentration

o This diluted concentration was determined after plating serial titers of the micro-organism and determining a concentration that yielded countable

One week incubation samples utilized a 100% concentration of P. aeruginosa

• A comparison was made between the relative difference of the two samples



DISCUSSION

Our study examined the performance of the new silver-impregnated PRO-GUARD[™] contact lens case and attempted to determine if it is more efficacious than the traditional lens case. Our results demonstrated a statistically significant reduction of *P. aeruginosa* when lenses were stored in the PRO-GUARD[™] vs. the traditional polyethylene case.

Difficulties Encountered:

- Establishing the amount of organisms concentrated in the original P. aeruginosa solution
- No growth with initial titer used, unable to determine if this was due to the incubation period, the concentration of microbes or efficacious nature of cases/solution.

Future Considerations

Future studies could explore the effectiveness of the PRO-GUARD[™] case against microbes other than *P. aeruginosa*. Different manufacturers use different plastics and ingredients in making their lens case, such as plasticizers in the Opti-Free[®] lens case to affect bacterial replication.² Therefore, consideration should also be given to comparing different manufacturer's cases to the PRO-GUARD[™] case to better understand its efficacy.

Because there are insufficient studies conducted to evaluate the advantages and disadvantages of silver ions in interfering with bacterial survival, it is important to investigate future ocular toxicity or allergic reactions that chronic exposure to silver may bring about with long-term use of the PRO-GUARD[™] lens case. Furthermore, Ciba recommends that the PRO-GUARDTM case be used with Aquify[®]. Future consideration should be given to the potential compatibility of other multi-purpose disinfecting solution with the PRO-GUARD[™] lens case or perhaps determine if this case's performance is only compatible with Aquify®. Perhaps the efficacy of the PRO-GUARD[™] cases will decrease over time as with all other conventional lens cases when used daily. It would be advantageous to study the length of time in which the PRO-GUARD™ case remains effective in reducing microbial growth as to ascertain the replacement interval of this lens case in a longitudinal study.

Furthermore, there is an inadequate amount of studies regarding the new PRO-GUARD[™] case. Perhaps the superior performance is due to the slow release of silver ions from the case, or due to the different plastic used by Ciba. The silver-impregnated technology may be the beginning of an improvement in targeting one of the main causative agents in contact lens contamination.

CONCLUSION

Numerous studies have come to the similar conclusion that good contact lens hygiene, compliance with proper MPDS usage, and mechanical cleaning of lenses is not adequate in retarding bacterial contamination to contact lenses.^{7,8} The majority of contamination of contact lens incidences is attributed to contact lens case contamination; therefore, methods of maintaining lens case free of microorganisms have been suggested by various studies. This study has demonstrated that the advent of the silver-impregnated PRO-GUARD[™] cases may be one solution to the dilemma of the contamination of contact lenses secondary to contaminated contact lens cases.

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Conflict of Interest Statement The authors have no proprietary or commercial interest in any of the products used in this study.