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Comparison of three separate one-step soft contact lens solutions in relation to patient sensitivity

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Abstract

Three new contact lens solutions have recently been approved by the FDA for one-step disinfection of soft contact lenses: Alcon's Opti-OneTM, Allergan's COMPLETE®, and Ciba's Quick CARE™. These solutions are indicated for use in the disinfection, daily cleaning, rinsing and storing of soft contact lenses. They are approved for direct placement on the eye with soft contact lenses. This investigation compared the relationship between the three solutions and subjective ocular comfort/sensitivity. Ninety subjects participated in one of three experimental sessions to compare the ophthalmic solutions. Ratings for ocular surface sensitivity to OptiOneTM, Quick CARE™, and COMPLETE®, demonstrated no statistically significant change from pre-instillation to post-instillation conditions. In addition, there was no consistent pattern of preference for one solution over another. In fact, in direct comparison of solutions, over forty percent of subjects reported no difference in ocular comfort.

Degree Type

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Degree Name

Master of Science in Vision Science

Committee Chair

Katherine A. Hinshaw

Subject Categories

Optometry

COMPARISON OF THREE SEPARATE ONE-STEP SOFT CONTACT LENS SOLUTIONS IN RELATION TO PATIENT SENSITIVITY

BY

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Adviser:

Katherine A. Hinshaw, O.D.

Signatures

Marc E. Brockman, Optometry Student

Chad A. Christenson, Optometry Student

Katherine A. Hinshaw, O.D., Adviser

BIOGRAPHY

Marc Brockman is a 1995 graduate from Pacific University College of Optometry. He received a Bachelor of Science degree in Physiological Psychology and a Bachelor of Arts degree in Sociology from the University of Washington. After undergraduate graduation he was employed at the Seattle VA Medical Center to conduct clinical research in diabetes and endocrinology. He is extremely interested in ocular disease and has been accepted for an ocular disease/geriatric residency at the Portland VA. Future goal is to become involved in a progressive co-management Optometric/Ophthalmological practice.

Chad Christenson is an optometry student who will graduate in the sping of 1997. He currently has a B.S. in Visual Science obtained at Pacific University. Optometric intrests include contact lenses and primary care optometry. Future goal is to establish a private practice in central Minnesota.

ABSTRACT

Three new contact lens solutions have recently been approved by the FDA for one-step disinfection of soft contact lenses: Alcon's Opti-One™, Allergan's COMPLETE®, and Ciba's Quick CARE™. These solutions are indicated for use in the disinfection, daily cleaning, rinsing and storing of soft contact lenses. They are approved for direct placement on the eye with soft contact lenses. This investigation compared the relationship between the three solutions and subjective ocular comfort/sensitivity. Ninety subjects participated in one of three experimental sessions to compare the ophthalmic solutions. Ratings for ocular surface sensitivity to Opti-One™, Quick CARE™, and COMPLETE®, demonstrated no statistically significant change from pre-instillation to post-instillation conditions. In addition, there was no consistent pattern of preference for one solution over another. In fact, in direct comparison of solutions, over forty percent of subjects reported no difference in ocular comfort.

ACKNOWLEDGEMENTS

We would like to personally thank Dr. Kathy Hinshaw for her excellent advice and suggestions regarding the thesis project. We couldn't ask for a better thesis advisor.

We would also like to thank the grand wizard of statistics, Dr. Bob Yolton, for all of his help in analyzing the immense data from this project.

Background:

Three new contact lens solutions have recently been approved by the FDA for one-step disinfection of soft contact lenses: Alcon's Opti-One™, Allergan's COMPLETE®, and Ciba's Quick CARE™. These solutions are indicated for use in the disinfection, daily cleaning, rinsing and storing of soft contact lenses. They are approved for direct placement on the eye with soft contact lenses. Ideally, these solutions should exert minimal toxicity and not in sensitivity reactions. Ocular sensitivity to ophthalmic solutions can be caused by several factors; type of preservative, pH, and osmolarity. These factors vary for different ophthalmic solutions. Therefore, it is important to address each of these separately.

Traditional disinfecting solutions containing chlorhexidine, thimerosal, or other mercury-containing ingredients have been shown to be toxic to the cornea.[1,2] COMPLETE® by Allergan utilizes polyhexamethylene biguanide (PHMB) as a disinfectant/preservative. PHMB is the same molecule as polyaminopropyl biguanide (PAPB) found in ReNu® Multi-Purpose Solution, but the two molecules differ in chemical structure of their monomer units. COMPLETE® (with 1 ppm PHMB) has higher D values (time to kill 1 log unit or 90% of test bacteria) in comparison to ReNu® (0.5 ppm PAPB).[3,4] Opti-One's Polyquad® is the same disinfectant/preservative used in its Opti-free™ formulation. Antimicrobial efficacy (D values) of Opti-One™ is comparable to COMPLETE®. Direct comparative studies have shown that the Quick CARE™ system, containing isopropyl alcohol, exhibits the greatest antimicrobial efficacy of the four soft contact lens solutions.[4]

The difference in pH between ophthalmic solutions and the tear layer can lead to corneal sensitivity reactions. The tears act to buffer instilled solutions. Studies have shown that the pH of the tear layer will return to normal ranges in 2-5 minutes after instillation of ophthalmic solutions with pH-5 and pH-9.[5] The pH of the tears ranges from 7.14 to 7.82 with a mean pH of 7.45.[6] However, the tear pH of dry eye patients has been found to be higher than that of normal patients.[7] Motolko and Breslin found that patients with dry eyes prefer tear substitutes with high pH.[8] There appears to be less likelihood of ocular irritation if the pH of an instilled ophthalmic solution is comparable to that of the patients own tear pH. Buffers added to contact lens solutions stabilize the pH, and maintain the solution's pH for hydrolysis of proteins. Citrate (Opti-One™), tromethamine (COMPLETE®), and borate (Quick CARE™) are common to contact lens solutions. Tromethamine has been shown to have a higher buffering capacity than citrate or borate.[3] Thus, the buffering capability of ophthalmic solutions decreases ocular irritation by maintaining pH and minimizing shifts associated with the instillation of ophthalmic solutions.

The hypertonicity of the ophthalmic contact lens solutions, relative to normal tear osmolarity, can also contribute to ocular sensitivity reactions. Tear osmolarity is a factor of the concentration of electrolytes in the tears. Gilbard found that the osmolarity of tears is elevated in patients with keratoconjunctivitis sicca.[9] Decreased blink rate and aqueous evaporation increase the tonicity of the tear layer. In addition, contact lens wearers exhibit increased tear osmolarity, and long term contact lens wear has been shown to

decrease corneal sensitivity.[10] Studies by Gilbard have further shown that decreasing corneal sensitivi[illegible] decrease tear secretion by approximately 70%.[11] This decrea[illegible] subsequent increase in tear layer osmol[illegible] corneal epithelium changes.[9] Thus, cl[illegible] layer, through the instillation of hyper[illegible] disrupts the corneal epithelial layer ar[illegible]

COMPARISON of THREE SEPARATE ONE-STEP CONTACT LENS SOLUTIONS IN RELATION TO PATIENT SENSITIVITY

MARC S. BROCKMAN ('95) : B
CHAD A. CHRISTENSON ('96) : B

Katherine A. Hinshaw, OD
4/27/95

Ocular surface sensitivity varies [illegible] structures in the eye. Millodot found [illegible] greatest in the anterior portion of the [illegible] the limbus.[12] This directly correlate[s] highest density in the center and dec[reases] periphery.[13] In comparison, conjunc[tival] levels of sensitivity. At the lid marg[in] begins to rival that of the peripheral [cornea] shown, both RGP's and soft contact l[enses] sensitivity.[15,16] Contact lens wear [can] weakens hemidesmosomal attachment [to] basement membrane.[17] This disru[pts] the epithelial layer and results in decreased sensitivity. [illegible] of corneal touch sensitivity, after extended periods of contact lens wear, can take a period of days to weeks.[19,20] This implies that long-term contact lens wearers may display decreased corneal sensitivity to ophthalmic solutions in comparison to non-contact lens wearers.

METHODS

Ninety subjects, between the ages of 20 and 56 years, were recruited from the student and faculty population at Pacific University in Forest Grove, OR. The following subjects were excluded from participation in the study: subjects under the age of 18, pregnant females and nursing mothers, those with current ocular infections or corneal disruptions, and those with ocular or systemic contraindications or allergies to any of the ophthalmic solutions used in the study. Subjects included 43 males and 47 females. Forty-seven (52.2%) of the subjects wore soft contact lenses, sixteen (17.8%) wore RGP's, and twenty-seven (30%) did not wear contact lenses. Subjects were not excluded from the study as a factor of contact lens wear.

Subjects participated in one of three experimental sessions to compare subjective ocular sensitivity of the following SCL solutions: Allergan COMPLETE®, Alcon Opti-One™, and Ciba Quick CARE™. SCL solutions were paired into three groups according to session: Group I (Alcon/Ciba), Group II (Alcon/Allergan), and Group III (Ciba/Allergan). This was done in order to allow for direct subjective comparison of one solution to another. A total of 180 eyes were tested in the study (60 for each solution).

Prior to beginning the study, SCL solutions were transferred to identical sterile dropper bottles and labeled A, B, and C (A=Opti-One™, B=Quick CARE™, and C=COMPLETE®). Subjects were given a questionnaire to assess ocular comfort prior to instillation of the drops (appendix A). Subjects rated different symptoms on a scale of one to seven (none-severe) for each eye separately. One solution

was randomly chosen to be instilled in one eye, while the contralateral eye received the other paired solution. One drop (approx. 40 ul) of each solution was instilled to simulate the amount of solution that would be received upon SCL insertion. Solutions were instilled onto the inferior conjunctiva with the patient looking up. Subjects were instructed to look straight ahead and blink normally. Drops were instilled by the same researcher for all conditions utilizing identical instillation techniques. The study was double masked so the subject and the researcher were not aware of which solutions were being instilled.

Two minutes after instillation of the drops, subjects filled out a post instillation questionnaire assessing subjective ocular comfort. The questionnaire was identical to the initial questionnaire, except for the inclusion of questions regarding patient contact lens wear (appendix B).

The same protocols were followed for each of the three experimental sessions.

RESULTS:

Each of the ten rated symptoms were summed and averaged over all subjects. Due to the nature of the grading scale, and as measures were intra-subject, an analysis of variance (ANOVA) test was used to analyze the data. Ratings for ocular surface sensitivity to Opti-One™, Quick CARE™, and COMPLETE®, demonstrated no statistically significant change from pre-instillation to post-instillation (tables1-10). The average changes in lid sensitivity from pre to post-instillation conditions are shown in figure 1. Lid itchiness

and redness decreased for all three solutions, while lid burning increased with Opti-One™ and Quick CARE™, but decreased with COMPLETE®. Subjects also rated Quick CARE™ and COMPLETE® as causing an increase in lid puffiness.

Figure 2 shows the average subjective change in ocular surface sensitivity, for the six rated items. Ocular surface itchiness, burning, and tearing all increased in symptomology, while redness, dryness, and sensitivity to lights decreased in symptomology.

The change in sensitivity from pre-instillation to post-instillation conditions for Opti-One™, relative to all ten rated measures, are shown in figure 3. Lid burning and ocular surface itching, burning and tearing, all increased after instillation of the Opti-One™. In comparison, lid itching, puffiness, and redness decreased, as did ocular redness, dryness, and light sensitivity. Of all the items assessed, ocular surface dryness showed the largest change from the pre-instillation to post-instillation conditions. Figures 4 and 5 show similar results for Quick CARE™ and COMPLETE®. There was very little change in lid sensitivity measures from the pre-instillation to post-instillation questionnaires for Quick CARE™ (figure 4). Ocular surface itching, burning, and tearing increased, while redness, dryness and light sensitivity decreased. Ocular surface dryness again exhibited the largest change; three times larger than any of the other measure. In comparison, COMPLETE® showed modest increases in lid puffiness, and ocular surface itching, burning and tearing from the pre-instillation to post-instillation conditions (figure 5). On the other hand, lid burning, and redness, and ocular surface redness, dryness, and sensitivity to lights all decreased in symptomology.

Intra-subject direct comparison of ocular comfort for the three different paired solutions revealed that forty percent of subjects in groups I and III, and forty-three percent of group II subjects reported no difference in ocular comfort when comparing one drop to another. Of those subjects in Group I (Opti-One™/Quick CARE™) that reported a difference in ocular comfort, 61% rated Quick CARE™ as less irritating to the ocular surfaces than Opti-One™ (39%). Group II (QuickCARE™/ COMPLETE®) subjects reporting a difference in ocular comfort preferred COMPLETE® (75%) over Quick CARE™ (25%), and Group III (Opti-One™/COMPLETE®) showed no preference for COMPLETE® (50%) over Opti-One™ (50%). Contact lens wearers did not show a statistically significant difference in ocular sensitivity or irritation, post instillation, in comparison to non-contact lens wearers.

Assessment of disinfecting solutions used by soft contact lens wearers in the investigation revealed a variety of solution brands. Overall, 38.8% used Renu®, 34.7% Opti-Free™, 8.1% Quick CARE™, and 6.1% COMPLETE®. These four accounted for 87.7% of all brands.

Discussion:

The results of this investigation indicate that there is no statistically significant difference in sensitivity/irritation between the three soft contact lens solutions. Quick CARE™, Opti-One™, and COMPLETE® all showed relatively little change in ocular irritation from pre-instillation to post-instillation subjective assessments. Each of the solutions, although differing in chemical composition for disinfecting and buffering agents, appear to be comparable in subjective comfort.

In addition, direct comparison of one contact lens solution to another failed to reveal a clear subjective preference. In comparing Opti-One™ to Quick CARE™, subjects preferred Quick CARE™, while subjects comparing Quick CARE™ to COMPLETE® preferred COMPLETE®. Comparison of Opti-One™ to COMPLETE® showed equal numbers of subjects preferred COMPLETE® as those that preferred Opti-One™. There was no consistent pattern of preference for one solution over another. In fact, in direct comparison of solutions, forty percent of subjects in groups I and III, and forty-three percent of subjects in group II reported no difference in ocular comfort.

Studies have shown that eyes exposed to RGP solutions exhibit corneal epithelial toxicity and staining.[21,22] Begley found significant corneal staining with the use of Boston Advance Conditioning Solution.[21] This accounts for the high percentage of patients reacting to the solution. Boston Advance Conditioning Solution™ contains polyaminopropyl biguanide (PAPB) the same disinfectant/preservative present in ReNu®, and similar to polyhexamethylene biguanide (PHMB) in COMPLETE®. Decreased corneal irritation with COMPLETE® and ReNu®, in comparison to Boston, can be accounted for by their relative low concentration of PAPB and PHMB. Boston Advance Conditioning Solution™ contains 30 to 50 times higher concentrations.[22] Thus, the results of this investigation can in part be attributed to the relatively low concentrations of disinfecting agents in the solutions.

An unexpected result of the investigation was the decrease in subjective symptoms of ocular dryness from pre-instillation to post-instillation for all three contact lens solutions. This result may be

due to an increase in reflex tearing in response to the ophthalmic solutions, or to the wetting effect of the solutions on the cornea. Subjective ratings showed that tearing increased for all three solutions post-instillation. In comparing the change in tearing from pre to post-instillation, we found that the increase in tearing was far less than the rated decrease in ocular dryness. Therefore, the change in ocular dryness cannot be accounted for simply as a factor of reflex tearing, but must also be a factor of the wetting effect of the solutions.

Only one subject reported an adverse reaction any of the soft contact lens solutions. The subject complained of a itchy, red eye within 15 minutes of instillation of Quick CARE™. Investigators evaluated the ocular surfaces and found palpebral and conjunctival hyperemia (+2), and mild chemosis. The patient was dispensed artificial tears and returned 2 hours later. Objective evaluation of ocular surfaces revealed no hyperemia or chemosis; no subjective complaints were reported at this time. Patient history revealed no prior history of reactions to any soft contact lens solutions.

Our results indicate that all three soft contact lens solutions are comparable in ocular comfort. Practitioners should consider patient history of solution reactions, compliance, and motivation in deciding which solution will work best for their patients.

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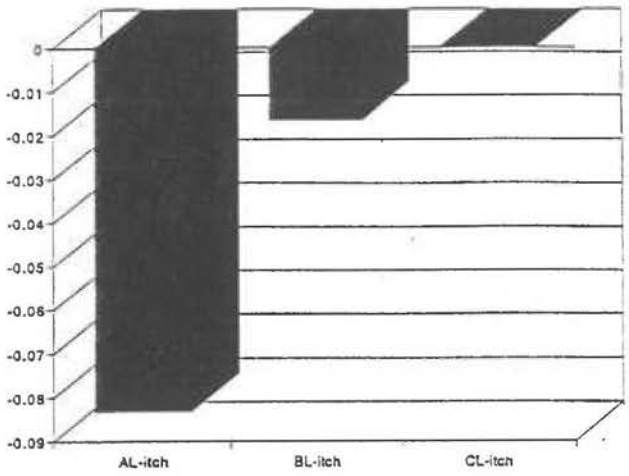
Figure 1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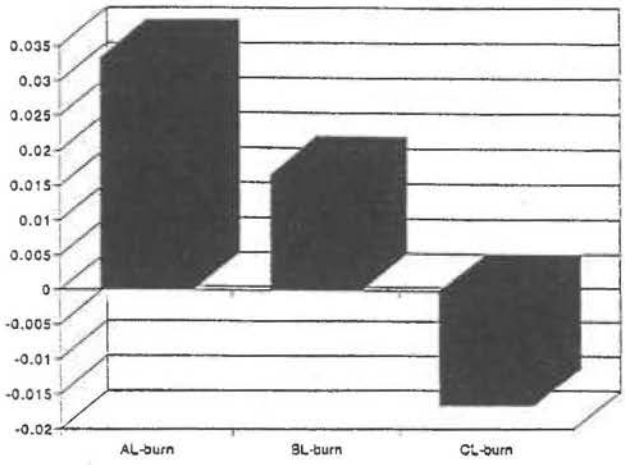
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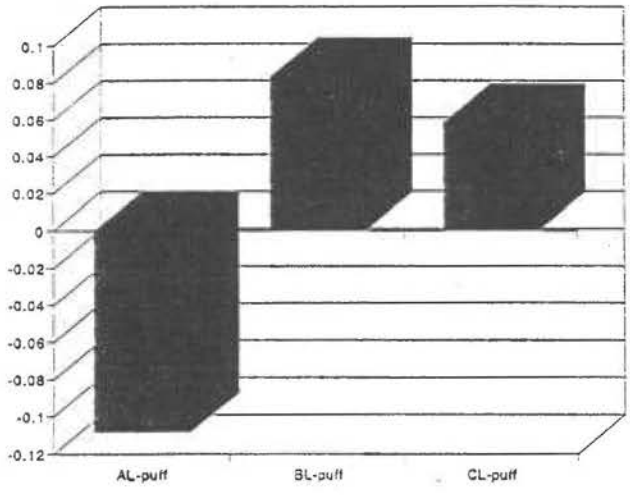
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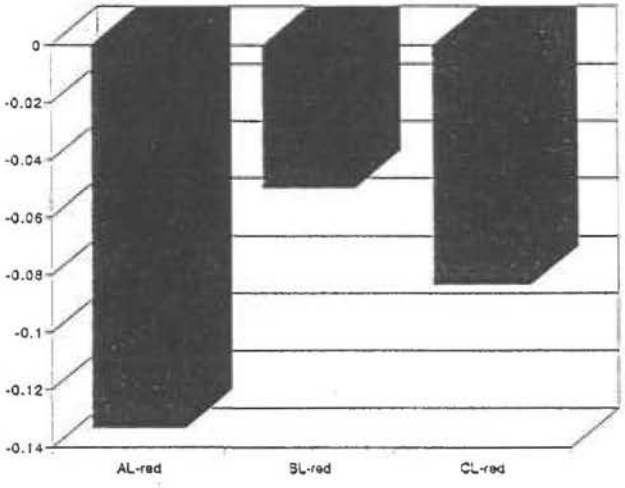
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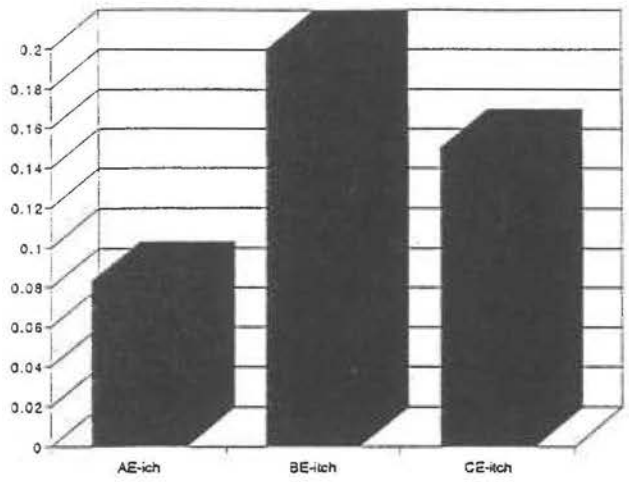
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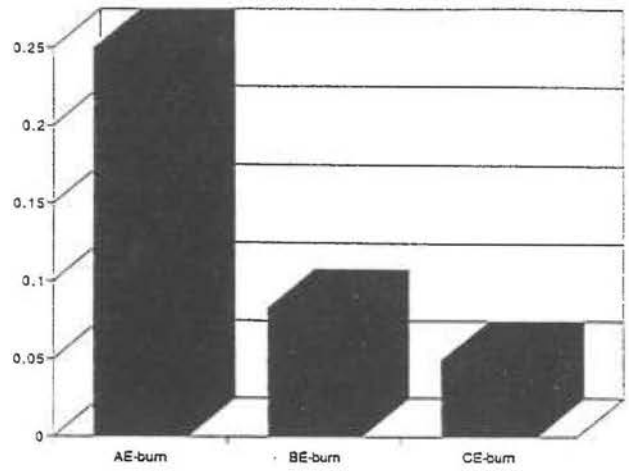
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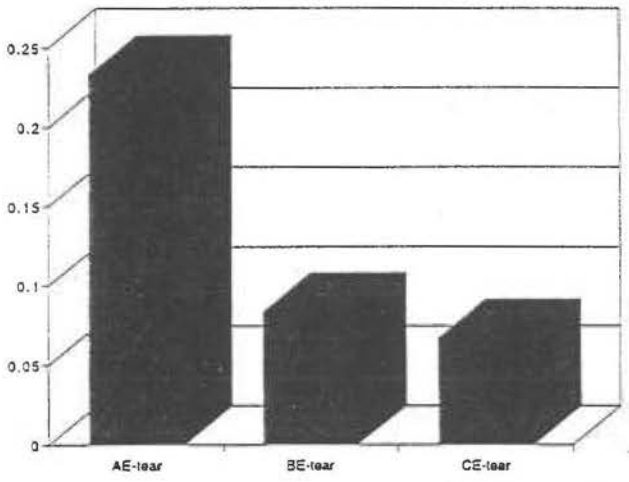
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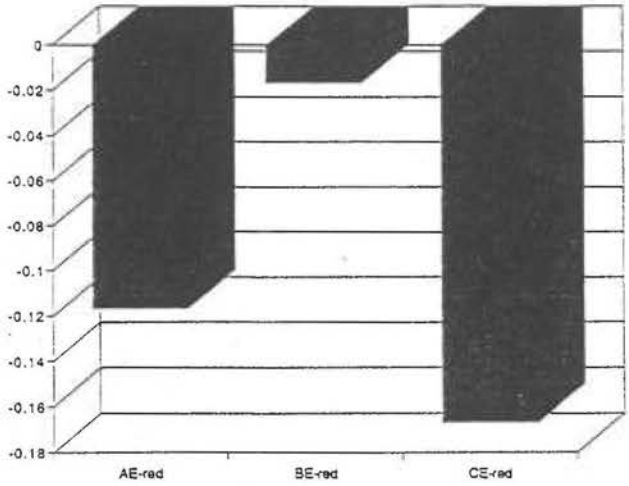
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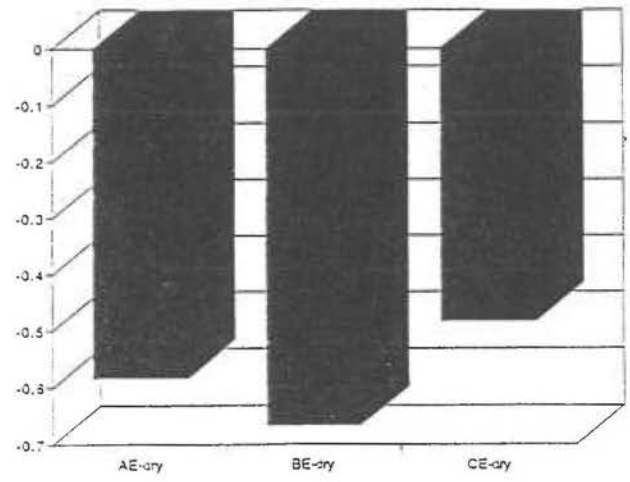
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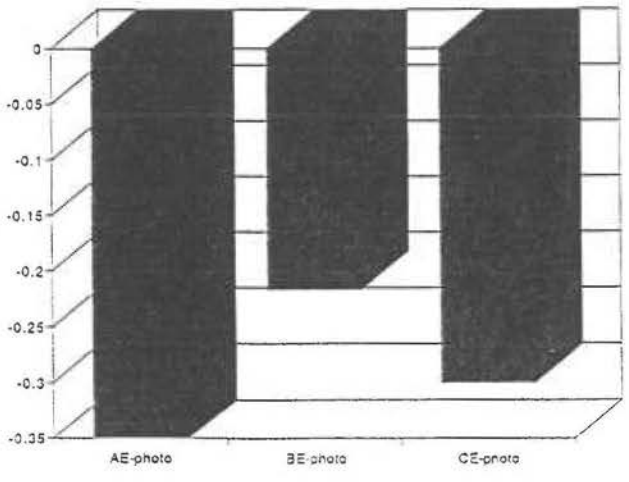
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Figure 3

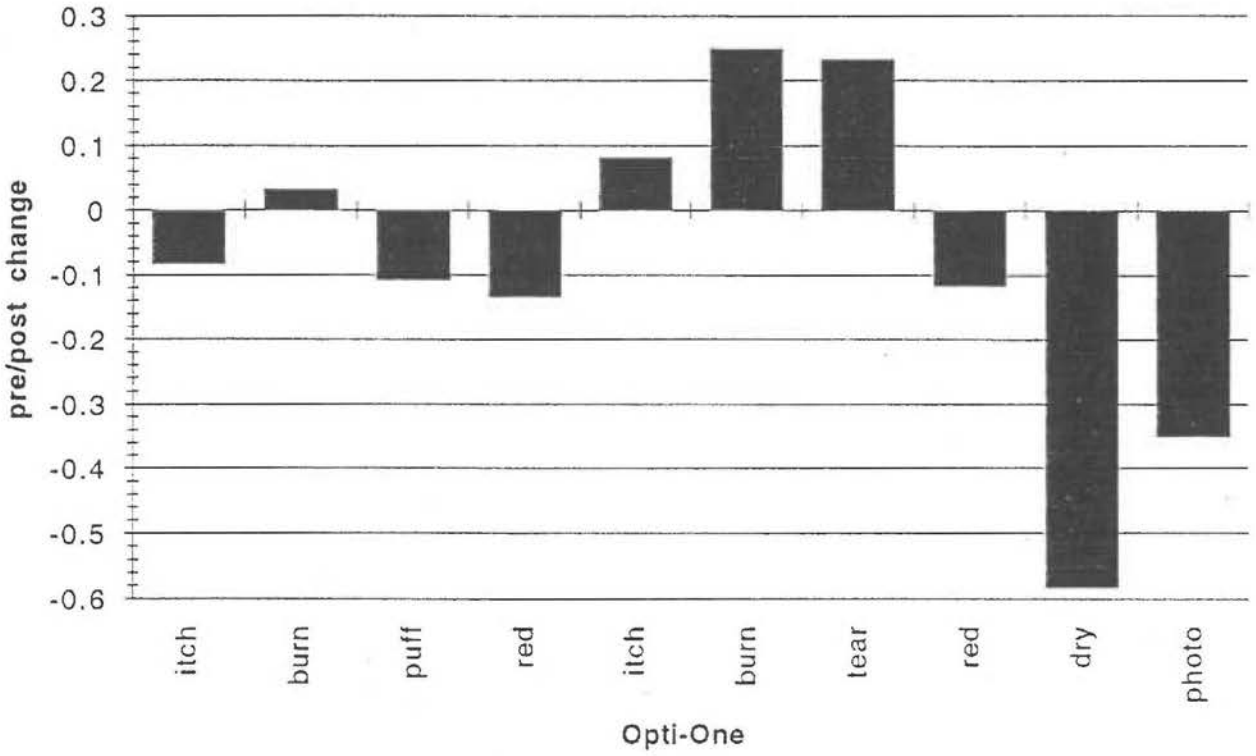
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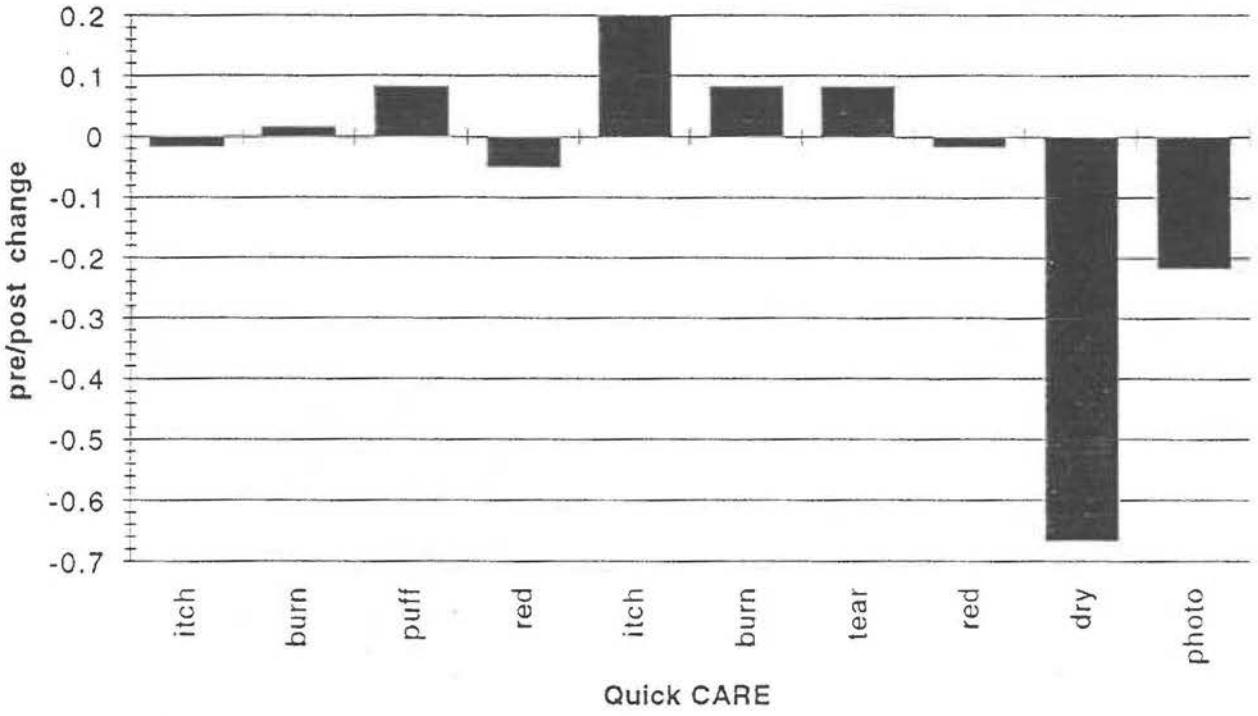
Figure 4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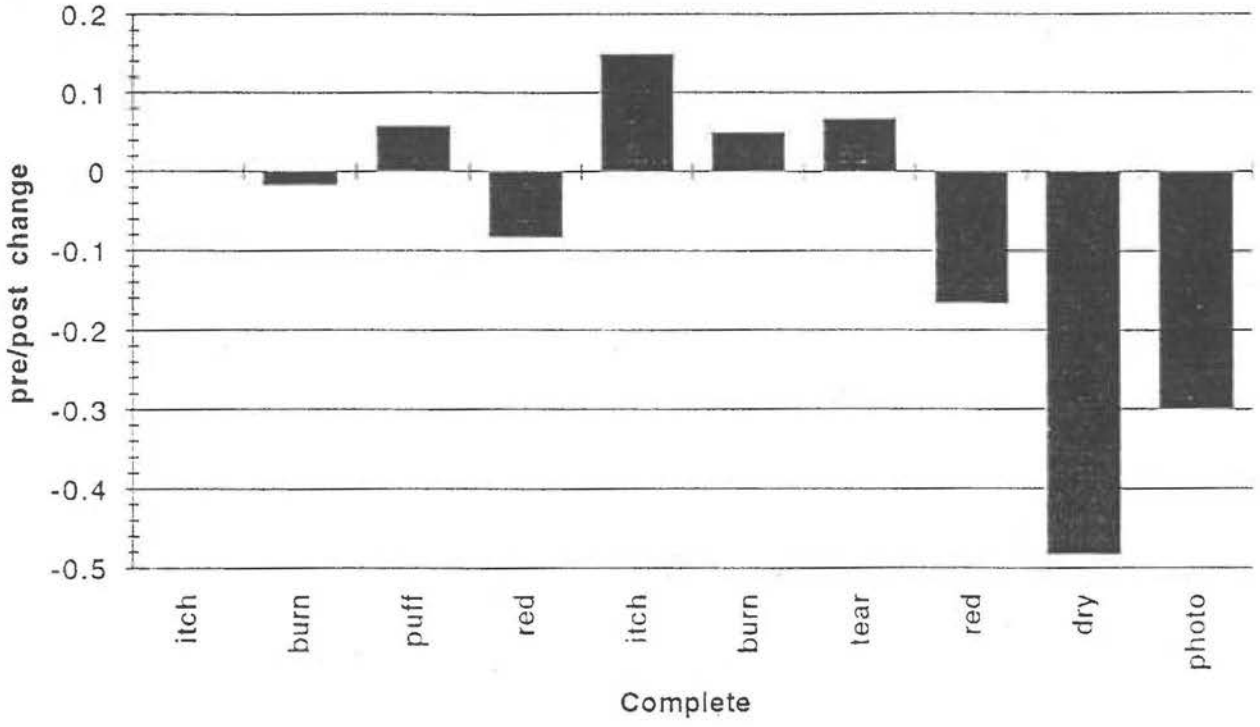
Quick CARE

Figure 5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Complete

Appendix A

CONTACT LENS SOLUTION SENSITIVITY STUDY

DATE: _____
PATIENT INITIALS: _____

GROUP: _____
RANDOMIZED: _____

SUBJECTIVE QUESTIONNAIRE:

I. LIDS: Rate the following symptoms, with regard to how your *eyelids* feel today, on the following scale:

1------2------3------4------5------6------7
none mild moderate severe

	Right Lid	Left Lid
Itching:	_____	_____
Burning:	_____	_____
Puffiness:	_____	_____
Redness:	_____	_____

II. EYES: Rate the following symptoms, with regard to how your *eyes* feel today, on the following scale:

1------2------3------4------5------6------7
none mild moderate severe

	Right Eye	Left Eye
Itching:	_____	_____
Burning:	_____	_____
Tearing:	_____	_____
Redness:	_____	_____
Dryness:	_____	_____
Sensitivity to lights:	_____	_____

III. In comparing overall comfort, which is the most true:
right eye is more comfortable than left: _____
left eye is more comfortable than right: _____
both eyes are the same: _____

Appendix B

PATIENT INITIALS: _____

SUBJECTIVE QUESTIONNAIRE:

(Please again rate how your eyes feel after receiving eyedrops)

I. LIDS: Rate the symptoms on the following scale, with regard to how your *eyelids* feel now after the drops were instilled:

1------2------3------4------5------6------7
none mild moderate severe

	Right Lid	Left Lid
Itching:	_____	_____
Burning:	_____	_____
Puffiness:	_____	_____
Redness:	_____	_____

II. EYES: Rate the symptoms on the following scale, with regard to how your *eyes* feel now after the drops were instilled:

1------2------3------4------5------6------7
none mild moderate severe

	Right Eye	Left Eye
Itching:	_____	_____
Burning:	_____	_____
Tearing:	_____	_____
Redness:	_____	_____
Dryness:	_____	_____
Sensitivity to lights:	_____	_____

III. In comparing overall comfort, which is the most true:
right eye is more comfortable than left: _____
left eye is more comfortable than right: _____
both eyes are the same: _____

IV. Background:
Do you currently wear contact lenses: Y N
Type of lenses worn: Soft Hard
How long have worn lenses (yrs): _____
Name of cleaning solution used: _____

Table 1

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	39.133	.663	2.595	.0001
Within subjects	120	30.667	.256		
treatments	2	.233	.117	.452	.6372
residual	118	30.433	.258		
Total	179	69.8			

Reliability Estimates for- All treatments: .615 Single Treatment: .347

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AL-itch	60	-.083	.462	.06
BL-itch	60	-.017	.567	.073
CL-itch	60	0	.803	.104

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AL-itch vs. BL-itch	-.067	.154	.258	.719
AL-itch vs. CL-itch	-.083	.154	.404	.899
BL-itch vs. CL-itch	-.017	.154	.016	.18

Table 2

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	33.978	.576	2.16	.0002
Within subjects	120	32	.267		
treatments	2	.078	.039	.144	.8663
residual	118	31.922	.271		
Total	179	65.978			

Reliability Estimates for- All treatments: .537 Single Treatment: .279

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AL-burn	60	.033	.52	.067
BL-burn	60	.017	.596	.077
CL-burn	60	-.017	.701	.09

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AL-burn vs. BL-burn	.017	.157	.015	.176
AL-burn vs. CL-burn	.05	.157	.139	.527
BL-burn vs. CL-burn	.033	.157	.062	.351

Table 3

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	49.811	.844	2.554	.0001
Within subjects	120	39.667	.331		
treatments	2	1.303	.651	2.004	.1394
residual	118	38.364	.325		
Total	179	89.478			

Reliability Estimates for- All treatments: .608 Single Treatment: .341

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AL-puff	60	-.108	.402	.052
BL-puff	60	.083	.809	.104
CL-puff	60	.058	.824	.106

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AL-puff vs. BL-puff	-.192	.173*	1.695	1.841
AL-puff vs. CL-puff	-.167	.173	1.282	1.601
BL-puff vs. CL-puff	.025	.173	.029	.24

* Significant at 90%

Table 4

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	54.578	.925	2.523	.0001
Within subjects	120	44	.367		
treatments	2	.211	.106	.284	.7529
residual	118	43.789	.371		
Total	179	98.578			

Reliability Estimates for- All treatments: .604 Single Treatment: .337

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AL-red	60	-.133	.596	.077
BL-red	60	-.05	.723	.093
CL-red	60	-.083	.889	.115

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AL-red vs. BL-red	-.083	.184	.281	.749
AL-red vs. CL-red	-.05	.184	.101	.45
BL-red vs. CL-red	.033	.184	.045	.3

Table 5

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	54.911	.931	2.018	.0006
Within subjects	120	55.333	.461		
treatments	2	.411	.206	.442	.644
residual	118	54.922	.465		
Total	179	110.244			

Reliability Estimates for- All treatments: .505 Single Treatment: .253

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-ich	60	.083	.72	.093
BE-itch	60	.2	.798	.103
CE-itch	60	.15	.84	.108

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-ich vs. BE-itch	-.117	.207	.439	.937
AE-ich vs. CE-itch	-.067	.207	.143	.535
BE-itch vs. CE-itch	.05	.207	.081	.401

Table 6

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	72.728	1.233	1.585	.0173
Within subjects	120	93.333	.778		
treatments	2	1.378	.689	.884	.4158
residual	118	91.956	.779		
Total	179	166.061			

Reliability Estimates for- All treatments: .369 Single Treatment: .163

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-burn	60	.25	1.144	.148
BE-burn	60	.083	.787	.102
CE-burn	60	.05	.928	.12

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-burn vs. BE-burn	.167	.267	.535	1.034
AE-burn vs. CE-burn	.2	.267	.77	1.241
BE-burn vs. CE-burn	.033	.267	.021	.207

Table 7

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	25.394	.43	2.279	.0001
Within subjects	120	22.667	.189		
treatments	2	1.011	.506	2.755	.0677
residual	118	21.656	.184		
Total	179	48.061			

Reliability Estimates for- All treatments: .561 Single Treatment: .299

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-tear	60	.233	.647	.084
BE-tear	60	.083	.497	.064
CE-tear	60	.067	.362	.047

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-tear vs. BE-tear	.15	.13*	1.839	1.918
AE-tear vs. CE-tear	.167	.13*	2.27	2.131
BE-tear vs. CE-tear	.017	.13	.023	.213

* Significant at 90%

Table 8

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	46.867	.794	2.103	.0003
Within subjects	120	45.333	.378		
treatments	2	.7	.35	.925	.3993
residual	118	44.633	.378		
Total	179	92.2			

Reliability Estimates for- All treatments: .524 Single Treatment: .269

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-red	60	-.117	.783	.101
BE-red	60	-.017	.701	.09
CE-red	60	-.167	.668	.086

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-red vs. BE-red	-.1	.186	.397	.891
AE-red vs. CE-red	.05	.186	.099	.445
BE-red vs. CE-red	.15	.186	.892	1.336

Table 9

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	113.24	1.92	2.93	.0001
Within subjects	120	78.67	.66		
treatments	2	1.01	.51	.77	.4661
residual	118	77.66	.66		
Total	179	191.91			

Reliability Estimates for- All treatments: .66 Single Treatment: .39

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-dry	60	-.58	1	.13
BE-dry	60	-.67	1.16	.15
CE-dry	60	-.48	.95	.12

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-dry vs. BE-dry	.08	.29	.16	.56
AE-dry vs. CE-dry	-.1	.29	.23	.68
BE-dry vs. CE-dry	-.18	.29	.77	1.24

Table 10

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Between subjects	59	40.311	.683	1.922	.0013
Within subjects	120	42.667	.356		
treatments	2	.544	.272	.763	.4687
residual	118	42.122	.357		
Total	179	82.978			

Reliability Estimates for- All treatments: .48 Single Treatment: .235

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
AE-photo	60	-.35	.777	.1
BE-photo	60	-.217	.454	.059
CE-photo	60	-.3	.766	.099

One Factor ANOVA-Repeated Measures for X_1 ... X_3

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
AE-photo vs. BE-photo	-.133	.181	.747	1.222
AE-photo vs. CE-photo	-.05	.181	.105	.458
BE-photo vs. CE-photo	.083	.181	.292	.764