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Master of Science in Vision Science

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Nada J. Lingel

Keywords

Anterior corneal mosaic, Goldmann tonometry, rigid gas permeable contact lens

Subject Categories

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CLINICAL EVALUATION OF ANTERIOR CORNEAL MOSAIC AS A PREDICTOR OF SUCCESSFUL CONTACT LENS WEAR

BY

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Abstract:

Goldmann tonometry was used to quantify pressure required to induce the anterior corneal mosaic pattern in 51 subjects. Sixteen subjects divided into high and low groups based on the pressure readings were fit with Fluoroperm 60 rigid gas permeable (RGP) contact lenses and followed for 3 months. Evaluation of keratometry, 3-9 staining, subjective comfort and vision, photoelectric keratoscope distortion and pachometry was performed. The study attempted to determine if the ease of inducing the mosaic pattern was related to the ability of subjects to wear RGP contact lenses successfully. Statistical analysis showed no significant difference between the groups.

Key Words: Anterior corneal mosaic, Goldmann tonometry, rigid gas permeable contact lens.

Introduction:

The anterior corneal mosaic is a polygonal pattern produced by gentle massage through closed eyelids. This pattern can be observed with the biomicroscope after fluorescein instillation, and is seen as a mosaic of interconnecting lines on the corneal surface. These interconnecting lines form a series of polygonal figures in a pattern resembling a honeycomb.[1] The amount of pressure required to induce this pattern is variable among the population. The time taken for the pattern to disappear is also variable, lasting from seconds to minutes. It has been shown that in a given cornea the mosaic pattern appears the same each time it is induced. The mosaic pattern has also been observed using numerous other methods, including applanation tonometry.

The exact cause of the mosaic pattern is unknown, but it may result from a particular arrangement of fibers in Bowman's membrane.[2] By flattening the cornea, tension on Bowman's membrane caused by normal intraocular pressure is relaxed. The formation of ridges is thought to occur in the membrane, causing compression of the overlying corneal epithelium, and resulting in pooling of fluorescein on the corneal surface. The lines of the pattern are not due to staining of the epithelium but by pooling over an irregular surface, as shown by the fact that the pattern disappears completely when the fluorescein is washed from the eye.

A previous study (Dangel, Kracher & Stark, 1984) noted the spontaneous presence of the anterior corneal mosaic in keratoconus patients wearing hard contact lenses.[3] The pattern occurred at the apex of the cone, where the greatest disparity between the corneal curvature and the curvature of the contact lens resulted in maximum corneal flattening. A low incidence of spontaneous anterior corneal mosaic was found in persons with normal corneas fitted with hard contact lenses. The authors suggested that the appearance of the mosaic in a normal cornea not previously demonstrating this pattern with hard contact lens wear may be a subtle indicator of keratoconus formation during the period of contact lens wear. The pattern's appearance may signify a gradual weakening of corneal structural integrity, made apparent by contact of the lens with the cornea.

Another study (Norn, 1968) was performed to quantify the amount of pressure required to induce the mosaic pattern.[4] Using Goldmann applanation tonometry, it was found that the pressure needed to elicit the pattern ranged from 0-69 mm Hg above the intraocular pressure of the subjects. The significance of the wide variability of pressure needed is unknown. We hypothesized that it may indicate differences in corneal structure, with the higher pressures signifying more corneal rigidity, which may be a factor affecting the degree of success with contact lens wear.

Present data used for screening prospective contact lens candidates includes, but is not limited to, assessment of corneal health, eyelid health, lid tension and closure, tear break-up time, age, refractive error and corneal toricity, along with previous history of contact lens wear. The purpose of this study was to determine if the ease of inducing the anterior corneal mosaic was related to a person's ability to wear rigid contact lenses successfully. We separated patients into high and low groups based on the observed mosaic pressure, and we expected the high group to be more successful with their contact lens wear. If a difference between groups was found, this measurement could be used by the clinician along with the other previously mentioned factors to predict whether or not a patient would be a good candidate for contact lens wear.

Methods:

Fifty-one subjects were selected from approximately 80 respondents to an advertisement for volunteers in the Portland area newspapers. Each volunteer answered a contact lens screening questionnaire in order to determine suitability for the study. Excluded from the study were those who had a history of contact lens wear within the last year or a history of corneal disease. Selected subjects received a comprehensive eye examination to establish baseline documentation of eye health and corneal and refractive data. Those with corneal toricity greater than 2.00 diopters were also excluded from the study.

To determine the minimum pressure necessary to induce the anterior corneal mosaic pattern for each of these 51 subjects, Goldmann tonometry was performed, using proparacaine 0.5% solution, fluorescein strips and a Goldmann attachment on a Mentor slit lamp. Two readings were taken on each eye on different days. One researcher collected all pressure data for consistency, and those performing fitting and follow-up examinations were unaware of the pressure readings on any subject. Readings were recorded at the point the mosaic pattern first appeared. Pressures necessary to induce the corneal mosaic pattern in the initial 51 people screened ranged from 10 mm Hg to 54 mm Hg, with a mean of 25.15 mm Hg and a standard deviation of 9.22 mm Hg (Table 1).

Sixteen subjects were then selected from the original group of 51 to be fit with contact lenses. These selections were based on the pressure needed to induce the corneal mosaic, with two experimental groups representing the high and low ends of the pressure range measured. There were 7 subjects in the high group and 9 subjects in the low group. Pressures in the high group ranged from 30 mm Hg to 47 mm Hg, with a mean of 35.86 and a standard deviation of 6.69. Pressures in the low group ranged from 12 mm Hg to 18 mm Hg, with a mean of 15.50 and a standard deviation of 2.65 (Table 2). An unpaired t-test showed that the two groups were statistically different with a probability of 0.0001.

Patient ages in the experimental groups ranged from 12 to 43, with a mean age of 28. There were 4 males and 3 females in the high group, with a mean refractive error of -1.46 D. sphere (standard deviation 1.37 D.) and -0.41 D. cylinder (standard deviation 0.38 D.).

The low group had 1 male and 8 females, with a mean refractive error of -2.60 D. sphere (standard deviation 1.14 D.) and -0.60 D. cylinder (standard deviation 0.51 D.).

Each subject was diagnostically fit with Fluoroperm 60 spherical rigid gas permeable contact lenses, using either a Mentor or Nikon slit lamp with cobalt blue and Kodak Wratten #12 filters. Lenses were quadracurves custom designed for each patient. Intermediate and peripheral curves were specified as 0.5, 1.5-1.7, and 3.0 mm flatter than the base curve. All contact lenses were verified using a Peak scope, B&L lensometer and a Reichart radiuscope. Modifications were done as needed during the initial few weeks of lens adaptation with a variable speed modifying unit and velveteen covered brass tools. All fits showed alignment or slight apical clearance fluorescein patterns with good tear exchange and adequate movement.

After dispense each subject was seen for a one week, one month, two month and three month progress evaluation. Patients were required to wear lenses for a minimum of four hours before data collection at each progress evaluation. Furthermore, patients were required to maintain at least four hours of daily lens wear throughout the study.

Each evaluation included a corneal evaluation with ratings of 3-9 staining using fluorescein strips, a cobalt filter, a Kodak Wratten

#12 filter and a Mentor or Nikon slit lamp. A grading scale of 0-4 was used for staining observation, represented by the following:

0 - no staining

1 - 1-50 discrete dots

2 - greater than 50 dots without coalescence

3 - greater than 50 dots with mild coalescence

4 - greater than 50 dots with extensive coalescence

Corneal distortion was evaluated using an International Diagnostic Instruments, Ltd. photoelectric keratoscope. Corneal edema was evaluated by central pachometry using a Diagnostic Concepts pachometer and an Apple IIc computer. Five pachometry readings were taken on each eye at each visit. Corneal curvature was measured using a calibrated B&L keratometer.

Patients also completed written questionnaires at each progress evaluation ranking comfort and vision on a scale of 1 to 10. For each ranking, 1 indicated the least desirable level of performance and 10 indicated the most desirable. Other routine progress measurements included visual acuity and over-refraction using either a B&L or AO Ultramatic phoropter. These were not done for statistical purposes but to insure adequate care of the patient.

Results:

Twelve of the sixteen subjects fit with contact lenses completed the study. One person in the high group and three in the low group did not complete the study for various reasons. A 15 year old myopic female in the low group experienced difficulty with lens insertion and lost motivation to continue after four weeks. A 43 year old myopic presbyopic male in the high group discontinued participation after two months, due to the inconvenience of having to wear glasses over contact lenses for reading. A 39 year old myopic male in the low group was terminated from the project due to lens intolerance. He experienced difficulty with decreased wearing time approximately six weeks into the study. It was determined that he had corneal exhaustion syndrome from long term PMMA (polymethyl methacrylate) contact lens wear. A 39 year old myopic female in the low group was also terminated from the project due to lens intolerance. She experienced large keratometry shifts, corneal edema, spectacle blur and discomfort. All four of the above patients had adequate lens fitting, movement and distance visual acuity of at least 20/20 with lenses.

Non-parametric data including vision, comfort and staining was statistically analyzed using the Mann-Whitney U test. Data from the 3-month follow-up evaluation was used for this analysis. There was no statistical difference between the high and low group for any of this data. A point of interest in the analysis pertains to the comfort data. Both the high and low groups had identical values and therefore a z-score equal to zero.

The changes in keratometry readings over time between the high and low groups were analyzed using ANOVA. The changes in horizontal and vertical measurements were analyzed separately. Data used for this analysis included the baseline and 3-month follow-up keratometry measurements. Our hypothesis that the groups differed in corneal rigidity, which would predict more corneal changes in the low group, was rejected as there was no statistical difference between the groups.

Photoelectric keratoscope data was not analyzed statisically as there were no subjects with gradeable corneal distortion resulting from lens wear.

Pachometry data was not analyzed statistically due to the wide variability in measurements by the researchers. There was no consistency in the readings for subjects from one visit to the next or even within the five measurements taken at each visit.

Discussion:

The original hypothesis that the high group would be more successful with their contact lens wear was rejected due to lack of statistical difference between groups. There were two limitations in the study that may have contributed to this fact. One is that a relatively small group of subjects (51) were initially screened for pressure measurements and observation of the mosaic pattern. Although a statistical difference was shown in the group selection, a greater number of patients screened might have allowed a wider spread than 12 mm Hg between the high and low groups. Probably the greatest limitation was the small number of patients in the study. Of the sixteen who were fit with contact lenses, four patients did not complete the project, one in the high group and three in the low group. As described previously, two quit voluntarily due to lack of motivation (one in each group) and two were terminated early by the researchers because of problems experienced with lens wear (both in low group). A future study incorporating a larger screening sample and a larger test group could possibly yield more meaningful results.

DATA AND STATISTICS

ABLE I – M SAIC PRESSURE

NUMBER OF EYES AT EACH PRESSURE RANGE (51 SUBJECTS)

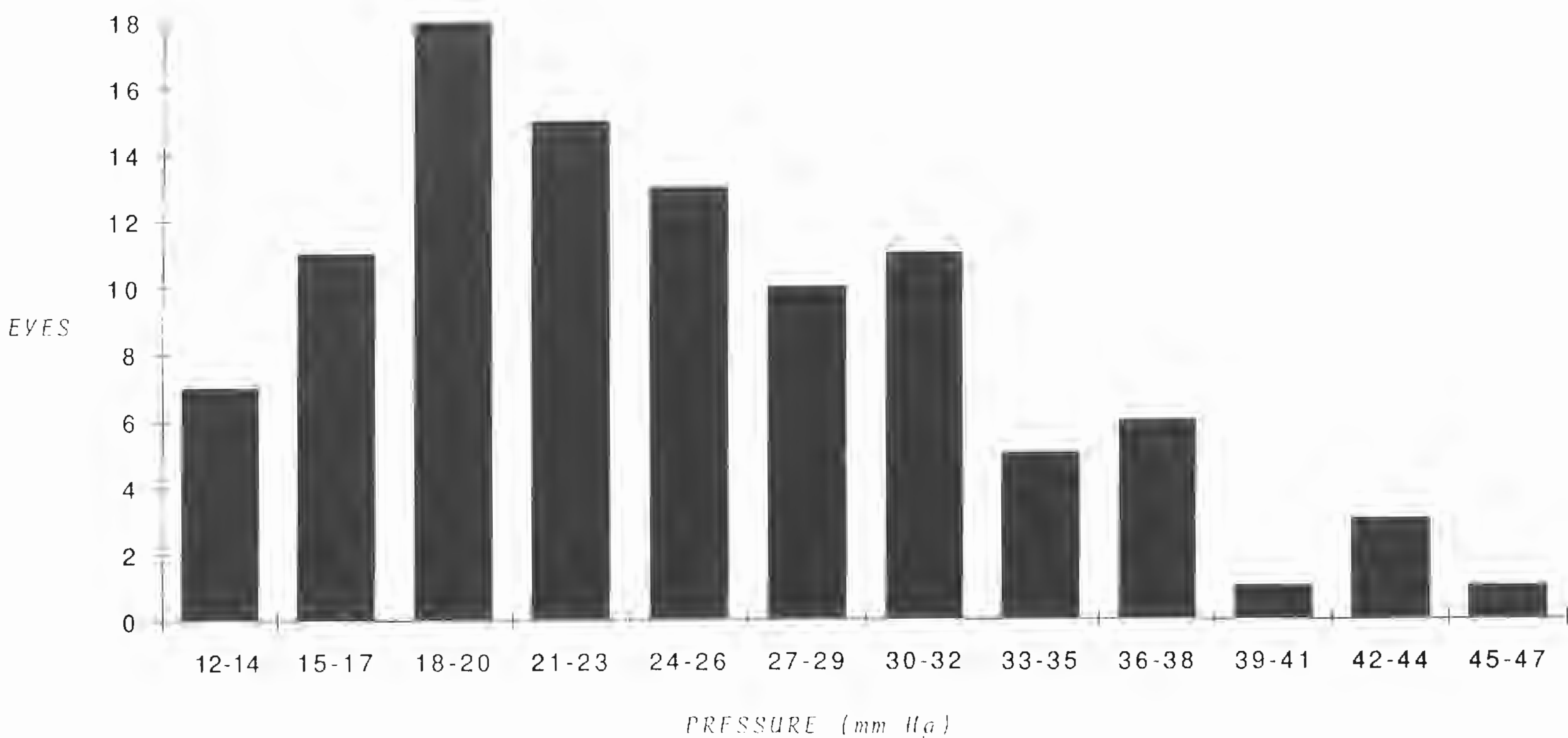
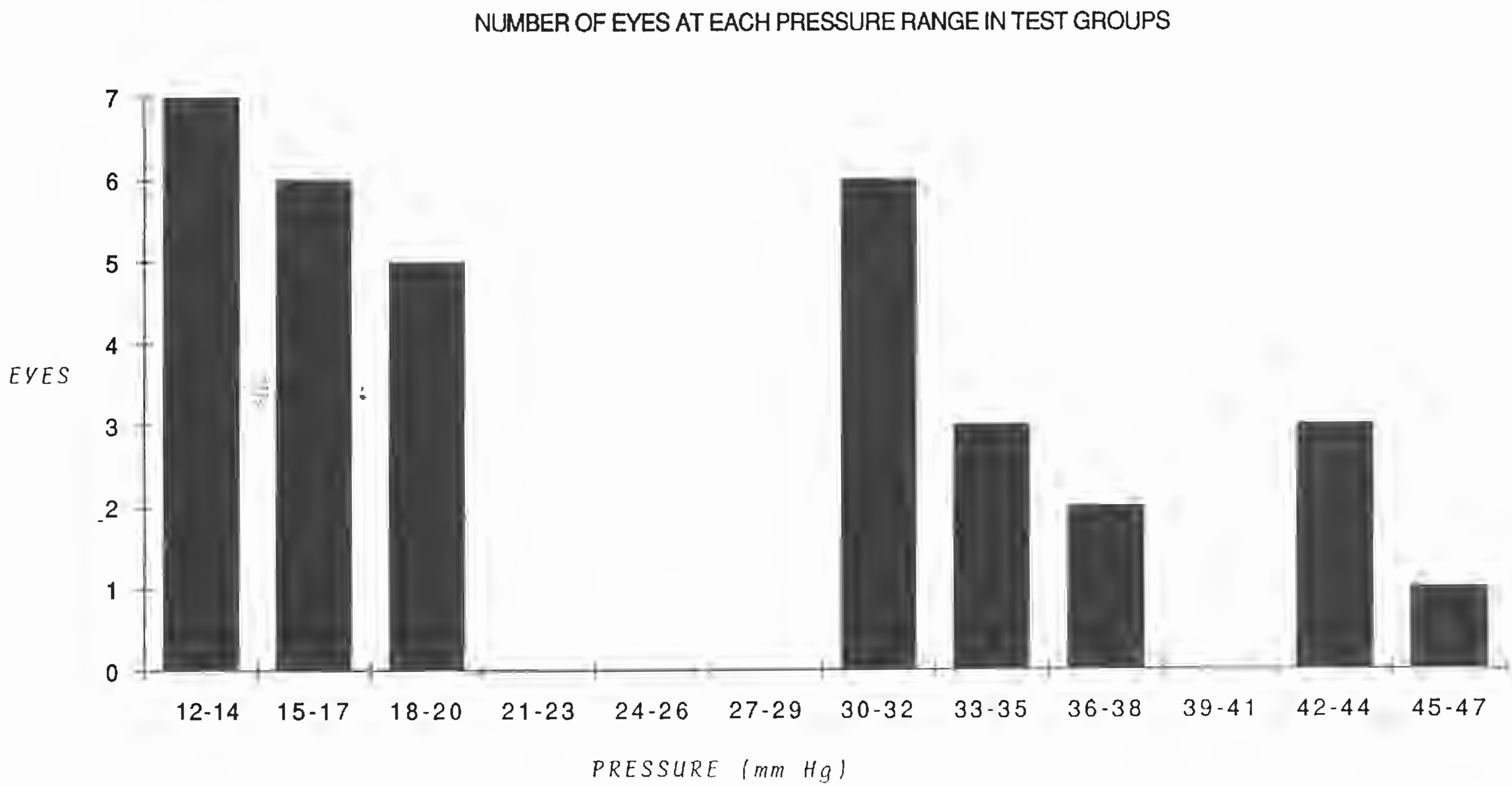


TABLE 2 - MOSAIC PRESSURE



HIGH VS. LOW GROUP MOSAIC PRESSURES COMPARED (16 SUBJECTS)

Unpaired t-Test X_1: GROUP Y_1: PRESSURE

DF:	Unpaired t Value:	Prob. (2-tail):
62	16.692	.0001

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
HIGH	28	35.857	6.687	1.264
LOW	36	15.5	2.646	.441

KERATOMETRY DATA (DIOPTERS): H=HORIZONTAL MERIDIAN, V=VERTICAL MERIDIAN

PATIENT # HI	H K'S-INITIAL	H K'S-1 WK	H K'S-1MO	H K'S-2MO	H K'S-3MO	DELTA H K	ABS DELTA H K	V K'S-INITIAL	V K'S-1 WK	V K'S-1MO	V K'S-2MO	V K'S-3MO	DELTA V K	ABS DELTA V K
1-OD	43.25	43.00	42.62	43.00	43.00	-0.25	0.25	43.37	42.87	42.50	43.00	42.87	-0.50	0.50
1-OS	43.00	42.62	42.12	42.50	42.50	-0.50	0.50	43.50	42.87	42.12	43.00	42.87	-0.63	0.63
6-OD	44.00	43.00	43.25	43.25	43.50	-0.50	0.50	44.00	43.00	43.00	43.50	43.00	-1.00	1.00
6-OS	43.87	43.00	43.00	43.25	43.25	-0.62	0.62	44.00	43.25	43.25	43.50	43.25	-0.75	0.75
7-OD	44.00	43.87	43.62	43.87	43.75	-0.25	0.25	43.50	43.25	43.00	43.12	43.12	-0.38	0.38
7-OS	43.62	43.50	43.50	43.37	43.50	-0.12	0.12	43.50	43.00	42.75	43.00	42.62	-0.88	0.88
10-OD	43.50	43.62	43.25	43.12	43.75	0.25	0.25	45.00	44.75	44.25	44.12	44.50	-0.50	0.50
10-OS	44.00	43.62	43.25	43.37	43.50	-0.50	0.50	45.25	44.75	44.50	44.25	44.50	-0.75	0.75
12-OD	43.62	43.62	43.25	43.25	43.75	0.13	0.13	43.00	43.12	42.75	43.00	43.00	0.00	0.00
12-OS	43.50	43.50	43.25	43.25	43.75	0.25	0.25	43.50	43.50	43.37	43.25	43.50	0.00	0.00
14-OD	43.50	43.25	43.37	43.25	43.00	-0.50	0.50	43.50	43.25	43.25	43.50	42.87	-0.63	0.63
14-0S	43.50	43.25	43.12	43.50	43.25	-0.25	0.25	43.50	43.25	43.25	43.50	43.12	-0.38	0.38
					MEAN DELTA K	-0.24	0.34					MEAN DELTA K	-0.53	0.53
PATIENT # LO														
2-OD	44.00	44.12	44.00	44.00	44.00	0.00	0.00	43.87	44.25	43.75	43.50	43.50	-0.37	0.37
2-OS	43.50	43.25	43.25	43.25	43.50	0.00	0.00	43.62	43.75	43.50	44.75	43.50	-0.12	0.12
3-OD	45.00	45.37	45.25	44.87	44.62	-0.38	0.38	46.12	46.00	46.00	45.25	45.25	-0.87	0.87
3-OS	45.12	45.00	44.75	44.37	44.37	-0.75	0.75	46.87	46.50	46.50	45.75	45.62	-1.25	1.25
5-OD	42.62	42.87	43.00	42.87	42.87	0.25	0.25	42.25	43.00	43.00	42.50	42.50	0.25	0.25
5-OS	42.75	42.87	42.75	42.62	42.75	0.00	0.00	42.50	43.00	42.87	42.25	42.50	0.00	0.00
13-OD	45.12	45.00	45.00	45.00	44.87	-0.25	0.25	44.50	44.62	44.25	44.75	44.87	0.37	0.37
13-OS	45.25	45.25	45.25	45.00	44.75	-0.50	0.50	45.00	44.87	44.00	44.50	44.75	-0.25	0.25
15-OD	42.75	42.37	42.25	42.50	42.50	-0.25	0.25	42.37	41.75	42.00	42.00	42.12	-0.25	0.25
15-OS	42.12	42.00	41.62	41.62	41.62	-0.50	0.50	42.62	41.75	41.12	41.25	41.37	-1.25	1.25
16-OD	42.25	42.25	42.25	42.50	42.50	0.25	0.25	43.25	42.50	42.75	42.50	42.62	-0.63	0.63
16-OS	42.62	42.50	42.50	42.62	42.50	-0.12	0.12	43.12	43.25	42.75	43.00	42.75	-0.37	0.37
					MEAN DELTA K	-0.19	0.27					MEAN DELTA K	-0.40	0.50

ABSOLUTE CHANGE IN KERATOMETRY READINGS AFTER 3 MONTHS LENS WEAR (DIOPTERS)

X_1: ABS HHDK

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.343	.169	.049	.029	49.184	12
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
.12	.62	.5	4.12	1.728	0

X_2: ABS LHDK

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.271	.232	.067	.054	85.591	12
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
0	.75	.75	3.25	1.471	0

X_3: ABS HVDK

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.533	.312	.09	.097	58.442	12
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
0	1	1	6.4	4.482	0

X_4: ABS LVDK

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.498	.417	.12	.174	83.648	12
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
0	1.25	1.25	5.98	4.891	0

ANOVA ANALYSIS OF HORIZONTAL K CHANGES

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN K

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	.032	.032	.767
Within groups	22	.905	.041	p = .3907
Total	23	.936		

Model II estimate of between component variance = -.01

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN K

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
HIGH	12	.343	.169	.049
LOW	12	.271	.232	.067

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN K

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
HIGH vs. LOW	.072	.172	.767	.876

ANOVA ANALYSIS OF VERTICAL K CHANGES

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN VK

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	.007	.007	.054
Within groups	22	2.98	.135	p = .818
Total	23	2.987		

Model II estimate of between component variance = -.128

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN VK

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
HIGH	12	.533	.312	.09
LOW	12	.498	.417	.12

One Factor ANOVA X_1: HIGH/LOW GROUPS Y_1: CHANGE IN VK

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
HIGH vs. LOW	.035	.312	.054	.233

COMFORT, VISION AND STAINING SCALE DATA

PATIENT # HI	COMFORT 1WK	COMF 1MO	COMF 2MO	COMF 3MO	VISION 1WK	VIS 1MO	VIS 2MO	VIS 3MO	STAIN 1WK	STA 1MO	STA 2MO	STA 3MO
1-OD	7	8	8	8	8	8	8	9	1.00	1.00	1.00	0.50
1-OS									0.50	1.00	2.00	0.50
6-OD	9	9	9	9	9	9	9	9	2.00	0.00	0.00	0.00
6-OS									2.00	0.00	0.00	0.00
7-OD	6	8	7	7	7	8	8	9	0.00	1.00	1.00	0.50
7-OS									0.00	1.00	1.00	0.50
10-OD	9	9	9	9	10	9	9	10	0.00	0.50	0.00	0.00
10-OS									0.00	0.00	0.00	0.00
12-OD	6	9	8	9	8	9	10	9	0.00	2.00	1.50	0.00
12-OS									1.00	2.00	1.00	0.00
14-OD	7	8	10	10	7	8	10	10	1.00	1.00	0.50	0.50
14-0S									0.00	0.00	0.00	0.00
			MEAN 3MO CO	8.67			MEAN 3MO VIS	9.33			MEAN 3MO ST/	0.21
PATIENT # LO												
2-OD	8	7	8	8	9	9	8	8	2.00	3.00	1.50	1.50
2-OS									0.50	1.00	1.00	0.50
3-OD	7	9	10	9	8	9	9	9	0.00	0.00	1.00	0.50
3-OS									0.00	0.00	1.00	0.50
5-OD	7	8	9	9	10	9	9	9	0.00	0.00	0.00	0.50
5-OS									0.00	0.00	0.00	0.50
13-OD	5	6	7	7	8	7	8	7	0.00	0.00	0.00	0.00
13-OS									0.00	0.50	0.50	0.00
15-OD	8	8	9	10	10	10	10	10	0.00	0.00	0.50	1.00
15-OS									0.00	0.00	0.50	1.50
16-OD	9	9	9	9	10	9	10	9	0.00	0.00	0.00	0.50
16-OS									0.00	0.50	0.00	0.00
			MEAN 3M0 CO	8.67			MEAN 3MO VIS	8.67			MEAN 3MO ST/	0.58

MEAN, STD. DEV., ETC. FOR COMFORT, VISION AND STAINING DATA

X_1: HCOMF 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
8.667	1.033	.422	1.067	11.917	6
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
7	10	3	52	456	6

X_2: LCOMF 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
8.667	1.033	.422	1.067	11.917	6
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
7	10	3	52	456	6

X_3: HVIS 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
9.333	.516	.211	.267	5.533	6
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
9	10	1	56	524	6

X_4: LVIS 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
8.667	1.033	.422	1.067	11.917	6
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
7	10	3	52	456	6

X_5: HSTAIN 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.417	.515	.149	.265	123.583	12
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum Squared:**	**# Missing:**
0	1	1	5	5	0

MEAN, STD. DEV., ETC. FOR COMFORT, VISION AND STAINING DATA

X_6: LSTAIN 3MO

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.917	.669	.193	.447	72.934	12

Minimum:	Maximum:	Range:	Sum:	Sum Squared:	# Missing:
0	2	2	11	15	0

MANN-WHITNEY U TEST RESULTS FOR COMFORT

Mann-Whitney U X_1: HI/LO Y_1: COMF

	Number:	Σ Rank:	Mean Rank:
Group 1	6	39	6.5
Group 2	6	39	6.5

U	18
U-prime	18
Z	0
Z corrected for ties	0
# tied groups	4

MANN-WHITNEY U TEST RESULTS FOR VISION

Mann-Whitney U X_1: HI/LO Y_1: VISION

	Number:	∑ Rank:	Mean Rank:
Group 1	6	46	7.667
Group 2	6	32	5.333

U	11
U-prime	25
Z	-1.121
Z corrected for ties	-1.261
# tied groups	2

MANN-WHITNEY U TEST RESULTS FOR STAINING

Mann-Whitney U X_1: HI/LO Y_1: STAIN

	Number:	Σ Rank:	Mean Rank:
Group 1	12	121	10.083
Group 2	12	179	14.917

U	43
U-prime	101
Z	-1.674
Z corrected for ties	-1.868
# tied groups	3

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