Assessing a Baseline Time for Contact Lens Removal and the Effect on the Stabilization of the Tear Film

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Introduction:

The use of corneal topographers in the optometric office is growing in popularity, especially with difficult contact lens fits and the surging popularity of LASIK. Since the removal of a hydrogel lens disrupts the tear film, it was of interest to see qualitatively and quantitatively via the use of a corneal topographer whether a clinically significant change occurs, and if so, how long of an amount of time until the tear film stabilizes. Also of interest was whether the readings would change after wearing the contact lenses for several hours (compared to one hour) due to possible dehydration of the lens. When patients come in for an optometric exam, some patients recently put the contact in prior to the exam, while others have worked for several hours with the lenses in. Therefore, it was of interest to see if any variation occurred from one hour of hydrogel wear versus six hours of hydrogel wear, and whether the findings can be applied to the clinical setting so that an optimal fit can be made.

Methods:

Five subjects (3 female and 2 male) ranging in age from 22 to 29 years of age were selected for this study. None of the subjects had problems with their current lenses in terms of comfort and fit. The types of hydrogel lenses used in this study were: Focus Visitint, Focus Dailies, Focus Toric, B&L Optima, and B&L Softlens 66. For further parameters, see table 2. The Humphries Corneal Topographer was utilized.

For the first part of the study, the subjects were instructed to wear the contacts for approximately one hour prior to testing. At that time, they were instructed to removed the lenses, and a topography was taken immediately. Four more topographies were then taken over the course of the next hour at fifteen minute intervals, so a total of five measurements were obtained.

For the second part of the study, the subjects were asked to wear the contact lenses continuously for six hours, and to perform their normal daily activities. When they returned back to the testing site, the same method of collecting the data as used in the first part of the study was done.

Analysis:

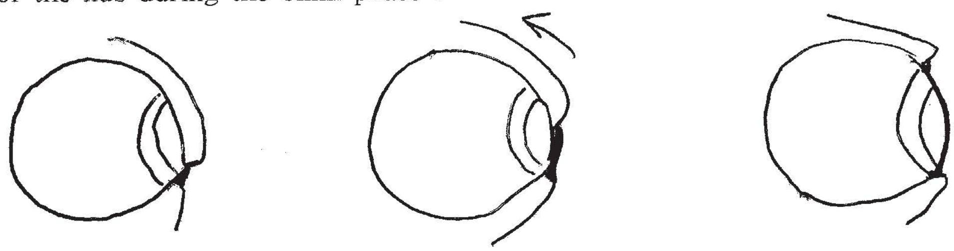
Delta K readings were taken from each of the five subjects for the five data intervals. Analysis of the 10 eyes was done using Lotus software. Averages of the delta K values along with standard deviations were performed (see table 1). Graphs were then made using the analyzed data, with the x-axis representing the time elapsed over the course of one hour and the y-axis representing the delta K values. Graph 1 depicts the changes after one hour of hydrogel wear and graph 2 depicts the changes after six hours of hydrogel wear. An overall change of .25D (t=0 to t=1hr) was considered clinically significant.

Most of the subjects showed very little changes in the delta K readings over the one hour of testing, with mainly a trend of 0.12-0.25 D change. One subject had an overall change of 0.37D. Comparing graph 1 with graph 2, it appears that after six hours of wear, the delta K value fluctuate more than after one hour of wear. The subjects with the most amount of fluctuation have the higher water content hydrogel lenses (Focus Dailies and B&L Softlens 66) with values of 69% and 66% respectively, but in turn have the highest Dk values (26 and 32, respectively). These "outliers" had a variations of 0.75D and 0.37D.

Four out of the ten eyes that had the hydrogel in for one hour prior to testing, had approximately 0.25D of change from the initial readings to the final readings one hour later. Three out of the ten eyes after six hours of hydrogel wear had a change of 0.25D for the initial readings to the final readings, but as stated in the above paragraph, the amount of fluctuation in the readings varied more with the six hour group than with the one hour group.

Discussion:

Tear film thickness varies from 6–12µm, with thin tear films being more prone to break up than thicker ones. The deposition of the tear film occurs during the opening phase of the lids during the blink phase[4].



Wong, Fatt and Radke's theory[12] (which is a modification of the Bretherton analysis[2]) assumed three conditions in order to have an ideal tear film distributed[1]:

1) The cornea is considered flat, and its radius of curvature is greater than that of the tear film thickness.
2) The tear film perfectly wets the surface of the cornea.
3) The aqueous portion of the tear film is a "Newtonian liquid with a viscosity μ and surface tension of σ."

In vivo studies have shown that evaporation has a negligible effect on the thickness of the tear film, but in hydrogel studies, it has been observed that there is a decrease in the tear film thickness[5]. It has been said that a hydrogel lens creates a pre and post lens tear film, which in turn can create an unstable tear film and increase the evaporation[8,10]. The edge of the hydrogel lens prevents an adequate spreading of the lipid layer and has been postulated that the amount for the tear film necessary to cover the hydrogel lens may not be enough[9,10]. Therefore, islands of lipid can form over the prelens aqueous, contributing to a disruption of the tear film and decreased TBUT time[9]. Research is currently underway to produce a tear supplement to help improve the stability of the lipid layer of the tear film.

Studies have also shown that hydrogel lenses dehydrate in vivo[11,5,1] due to the evaporation from the front lens surface and from an increase in the lens temperature[6,7]. Cederstaff and Tomlinson have demonstrated that the tear film is disrupted with a hydrogel lens, which in turn contributed to increased evaporation[3]. The exact cause of the disruption of the tear film is not known. After several hours of hydrogel wear, Pritchard and Fonn[11] determined that lens movement and symptoms of dryness did not occur, even though the hydrogel lens exhibited dehydration over the time period. However, others (Efron and Lebow[5,6]) have suggested that lens dehydration does contribute to decreased lens comfort. This area is of much interest, and further research need to be performed to help maximize comfort of lenses, while decreasing the tendency of lens dehydration.

Conclusion:

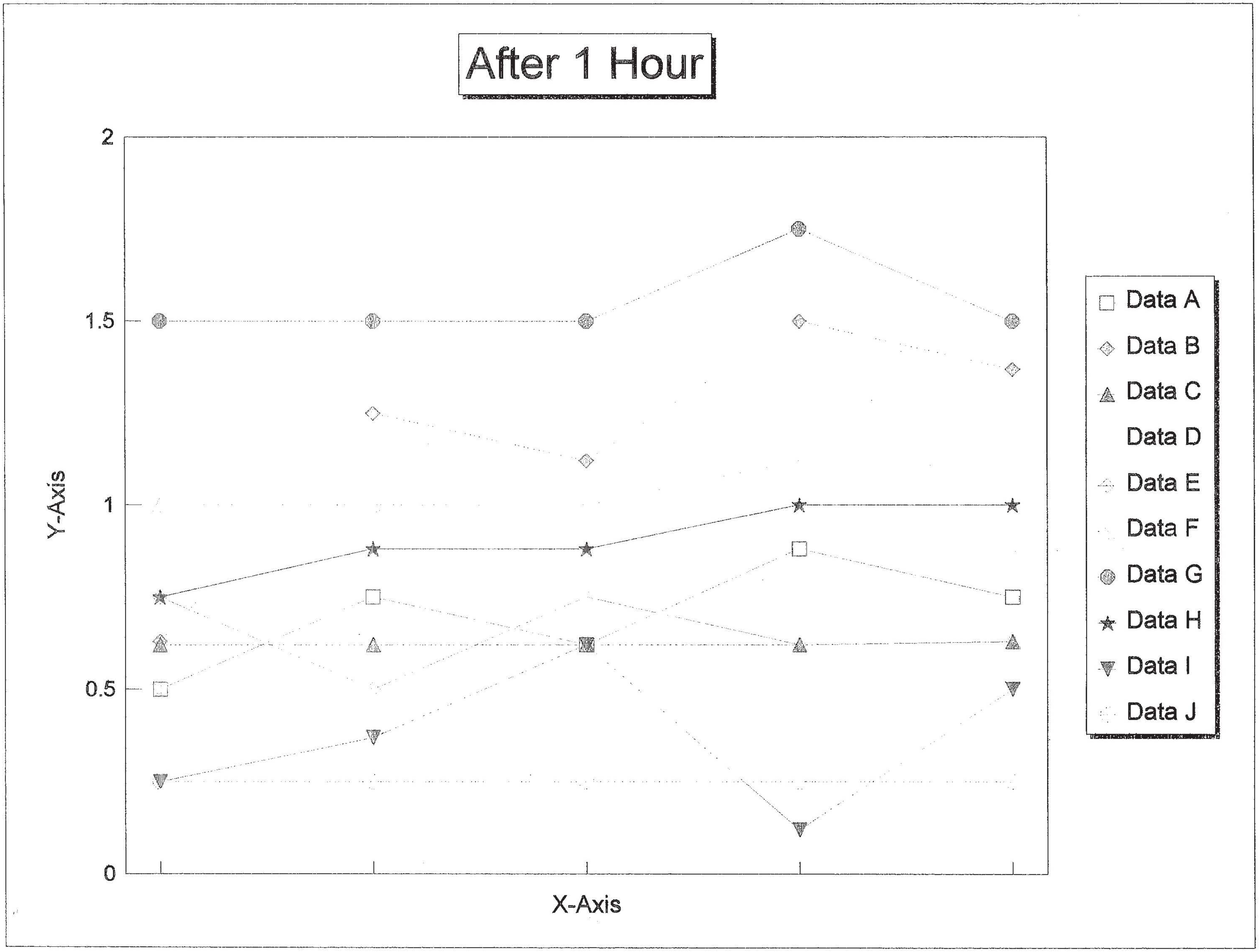
There does not appear to be strong clinical evidence that the tear film is disrupted by a significant amount after the removal of a hydrogel lens. The variability of the delta K readings were not predictable enough to determine a trend (or rule of thumb) over the course of one hour, and there was not a specific time that the readings equalized for the ten eyes. Although four out of the ten subjects after one hour of wear time, and three out of the ten after 6 hours of wear time had a change of 0.25 D, it was not greater than 50% of the subject, which in turn was not enough to call clinically significant. Therefore, taking the topographies of a patient does not appear to be of concern whether they are taken immediately after removing the lens compared to waiting a set amount of time prior to taking the readings. Not included in this study, but are of interest for further research is whether the addition of a lubricating drop prior to the topography has a significant difference of the readings (masking of the actual delta K values) and how RGP wearers would fare with the same testing methods as this study.

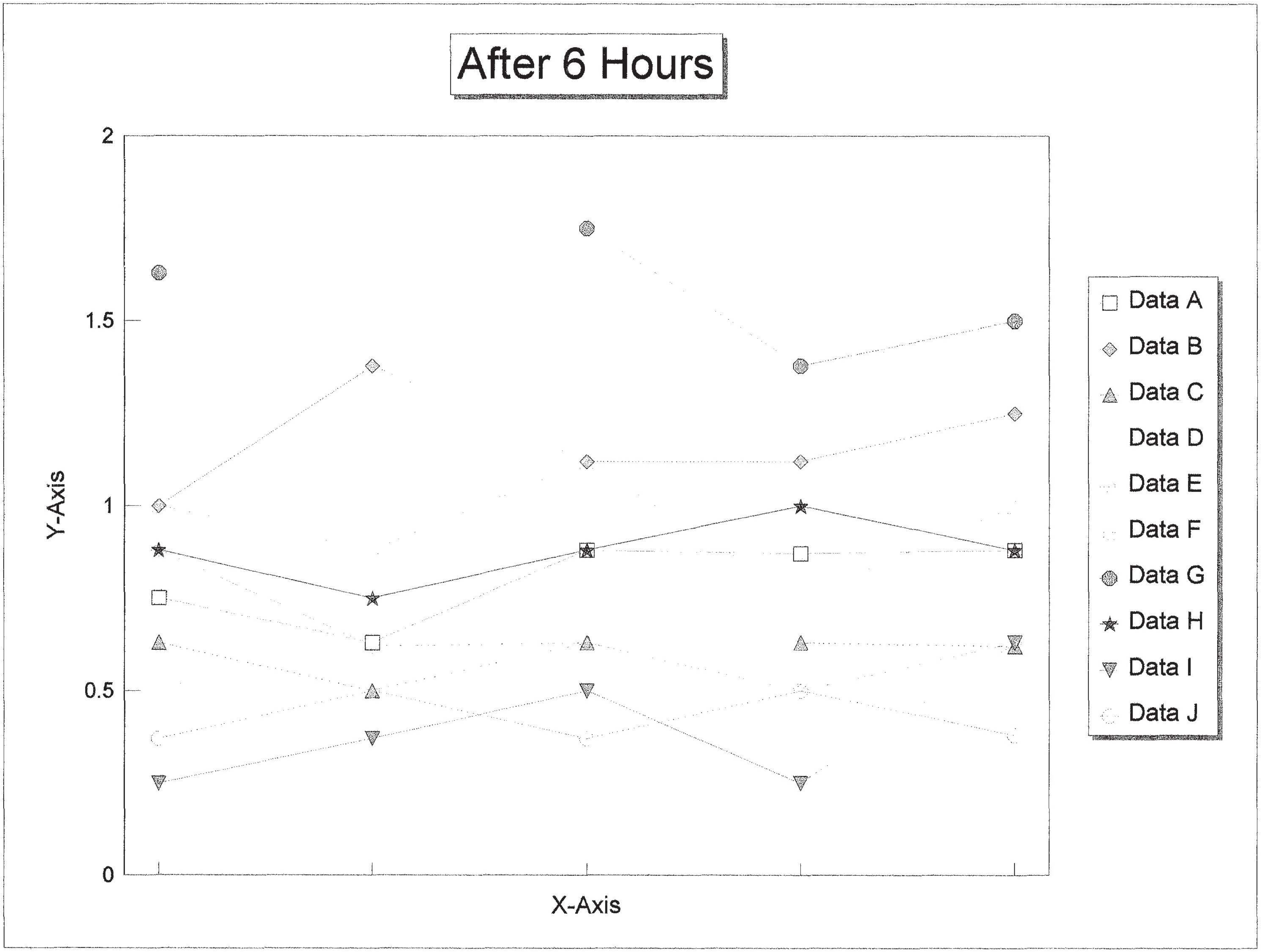
Appendix

		Delta K Values and Analysis of Data							
ZB (OD 1hr)		JP(OD 1 hr)		GS(OD 1hr)		FK(OD 1hr)		SK(OD 1hr)	
0.50		0.63		0.62		0.88		0.75	
0.75		1.25		0.62		0.50		0.50	
0.62		1.12		0.62		0.50		0.75	
0.88		1.50		0.62		0.25		0.62	
0.75		1.37		0.63		0.62		0.63	
3.50	**Sum**	**5.87**	**Sum**	**3.11**	**Sum**	**2.75**	**Sum**	**3.25**	**Sum**
0.700	**Avg**	**1.174**	**Avg**	**0.622**	**Avg**	**0.550**	**Avg**	**0.650**	**Avg**
0.1447	**Std Dev**	**0.3352**	**Std Dev**	**0.0045**	**Std Dev**	**0.2285**	**Std Dev**	**0.1046**	**Std Dev**
ZB (OS 1 hr)		JP(OS 1 hr)		GS(OS 1hr)		FK(OS 1hr)		SK(OS 1 hr)	
1.00		1.50		0.75		0.25		0.25	
1.00		1.50		0.88		0.37		0.25	
1.00		1.50		0.88		0.62		0.25	
1.12		1.75		1.00		0.12		0.25	
0.87		1.50		1.00		0.50		0.25	
4.99	**Sum**	**7.75**	**Sum**	**4.51**	**Sum**	**1.86**	**Sum**	**1.25**	**Sum**
0.998	**Avg**	**1.550**	**Avg**	**0.902**	**Avg**	**0.372**	**Avg**	**0.250**	**Avg**
0.0884	**Std Dev**	**0.1118**	**Std Dev**	**0.1040**	**Std Dev**	**0.1977**	**Std Dev**	**0.0000**	**Std Dev**
ZB (OD 6 hr)		JP(OD 6hr)		GS (OD 6hr)		FK(OD 6hr)		SK(OD 6hr)	
0.75		1.00		0.63		0.50		0.88	
0.63		1.38		0.50		1.25		0.62	
0.88		1.12		0.63		0.63		0.63	
0.87		1.12		0.63		0.63		0.50	
0.88		1.25		0.62		1.25		0.63	
4.01	**Sum**	**5.87**	**Sum**	**3.01**	**Sum**	**4.26**	**Sum**	**3.26**	**Sum**
0.802	**Avg**	**1.174**	**Avg**	**0.602**	**Avg**	**0.852**	**Avg**	**0.652**	**Avg**
0.1108	**Std Dev**	**0.1452**	**Std Dev**	**0.0572**	**Std Dev**	**0.3672**	**Std Dev**	**0.1388**	**Std Dev**
ZB(OS 6 hr)		JP (OS6hr)		GS (OS 6hr)		FK(OS 6hr)		SK(OS 6hr)	
1.00		1.63		0.88		0.25		0.37	
0.88				0.75		0.37		0.50	
1.12		1.75		0.88		0.50		0.37	
0.75		1.38		1.00		0.25		0.50	
1.00		1.50		0.88		0.63		0.38	
4.75	**Sum**	**6.26**	**Sum**	**4.39**	**Sum**	**2**	**Sum**	**2.12**	**Sum**
0.950	**Avg**	**1.565**	**Avg**	**0.878**	**Avg**	**0.400**	**Avg**	**0.424**	**Avg**
0.1404	**Std Dev**	**0.1601**	**Std Dev**	**0.0884**	**Std Dev**	**0.1649**	**Std Dev**	**0.0695**	**Std Dev**

Table 2: Hydrogel Lenses Used

Lens	%Water	Dk	Diameter	Power	CT
Focus Toric	55	16	14.5	-0.75 -1.25 x 120 -0.75 -1.25 x 040	0.146
Focus Dailies	69	26	13.8	-6.00 DS -6.00 DS	0.10
Ciba Focus	55	16	14.0	-7.00 DS -7.00 DS	0.06
Softlens 66 Toric	66	32	14.5	-2.25 -1.25 x 010 -2.50 -1.75 x 170	0.195
B&L Optima	38.6	8.4	14.0	-4.00 DS -4.25 DS	0.035


After 1 Hour
2
1.5
1
0.5
0
Y-Axis
X-Axis
Data A
Data B
Data C
Data D
Data E
Data F
Data G
Data H
Data I
Data J


After 6 Hours
2
1.5
1
0.5
0
Y-Axis
X-Axis
Data A
Data B
Data C
Data D
Data E
Data F
Data G
Data H
Data I
Data J

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