B.S.S.

Senior Project

Residual Astigmatism, Hydrogel Flexure, and Visual Acuity with Hydrogel Lenses: A Comparative Study

Richard Gay

Ferris State University
College of Optometry

Advisor: Gerald Lowther, O.D.,Ph.D.

Introduction: Patients that have between .50 to 1.25DC of astigmatism can be fitted with contact lenses in several ways in clinical practice. The simplest way to fit them is with a spherical hydrogel lens with the spherical equivalent of the refractive error. This is a comfortable option, however, many patients complain of blurred vision. A hydrogel lens will generally transfer corneal cylinder to the front surface of the lens. Some studies, however, have reported little or no reduction in visual acuity with hyrogel lenses despite residual astigmatism of up to 2.25 DC(1). Another study used 76 patients that had between .25 to 1.5DC and found that 70% of the patients had 20/20 vision or better using spherical hydrogel lenses(2). Many patients will complain, however, about a decrease in visual performance while they still have 20/20 vision. The aspect of low amounts of astigmatism affecting contrast has been mentioned in the literature(3). The insufficient correction of astigmatism in contact lens wearers has the same variety of symptoms as spectacle corrected wearers. A variety of symptoms such as blur, head aches, eye strain and distortion are common.

The second way to fit the low astigmatic patient would involve using a Rigid Gas Permeable lens. The RGP lens, if designed properly, will not flex and will correct corneal cylinder by forming a tear layer in between the lens and the cornea. The hard lens patient usually has less residual astigmatism than the hydrogel patient. The hard lens does have several drawbacks: the RGP lens usually takes the practioner longer to trial and design, can not be stocked for same day service for a reasonable amount of money, and generally is not as comfortable as a hydrogel lens.

The third method used to fit the low astigmatic patient is with a toric hydrogel lens. The toric hydrogel lens has a cylindrical component built in to it to correct the astigmatism. It is a soft lens and most patients find it to be more comfortable than the RGP lens. Drawbacks to this lens include: the toric hydrogel lens takes longer to trial and design, can not be stocked for same day service for a reasonable amount of money, may rotate for the patient while on the eye causing fluctuating vision, and many times has manufacturing variances and inconsistancies.

The two variables that this experiment is trying to test are increasing thickness of a hydrogel lens with hema, and using a non hema standard thin hydrogel lens. The Hydron Mini and the Ciba Std. lens are both about twice the thickness of the Hydron Zero 6 control lens. An American Hydron representive spoke of the Mini lens as having the capability to correct up to 1.25DC of corneal astigmatism. The CSI lens is made from glyceryl-methyl methacrylate and is said to have more body(4). A premarketing clinical study reported that of the ten patients previously wearing Bausch

& Lomb lenses, all agreed that the vision and handling were better with CSI lens(5).

Objective: The purpose of this study is to determine if low amounts of corneal astigmatism can be reduced with spherical hydrogel lenses. This study compares and contrasts the abilities of three lenses reported to correct low to medium amounts of corneal astigmatism and improve visual acuity. The results were analyzed between the three lenses and one standard thin hydrogel lens as a control. The ability to fit the patient with marginal amounts of corneal astigmatism with a spherical hydrogel lens that cannot normally obtain good visual acuity unless wearing a rigid gas permeable or a toric hydrogel lens was investigated. The lenses tested were the Hydron Mini lens, the CSI lens, and Ciba Visitint Std. lens. The Hydron Zero 6 lens was used as a thin lens control(see Table 1 for specifications).

Method: Nine volunteer subjects(fifteen eyes total) were used that had between .50 to 2.50DC(mean .90D) of astigmatism that is matched by the cornea(mean .92D corneal cyl.). An initial refraction and keratometry was performed on each subject to determine if they qualified for the test. Many subjects had acceptable amounts of refractive cylinder but not enough corneal cylinder. This was especially common among low against the rule astigmats in which the lens is responsible for the astigmatism and not the cornea. Subjective responses to the Jackson Cross Cylinder test were used to determine the amount of refractive astigmatism. A subjective response of no difference to the lens choices was treated as the correct cylinder power amount. If the subject did not achieve equality, then the lesser amount was used each time. Visual acuity was then taken. A single line 20/20 projected chart was used.

One of the lenses was then put on the patient and allowed to stabilize for five to ten minutes. The proper fit and centering of the lenses was then evaluated. The slit lamp was used to determine if the the lens centered well and had proper movement of .5 to 1.5mm. Only properly fitted lenses were used. Over keratometry readings were then taken. A spherical over refraction was then taken with visual acuities. Then, a sphero-cylindrical refraction was performed and visual acuities were again taken. This was then repeated on the other three lenses. Different equipment was used on different subjects, but the goal of the experiment was to measure change in refractive and keratometric cylinder and not absolute values, so the equipment variance should have little effect.

Results: There were three main areas of comparison: spectacle cylinder vs. residual cylinder, keratometry vs over keratometry, and spectacle visual acuity vs. contact lens visual acuity with a spherical over refraction. Table 2 has a summary of the statistics.

The mean amount of spectacle cylinder was .90DC with a range of .50 to 2.50DC. The mean amount of residual cylinder with the Hydron Zero 6 lens was .85DC with a range of .25 to 2.25DC. The mean amount of residual cylinder with the Hydron Mini lens was .63DC with a range of 0 to 2.25DC. The Ciba Std. lens had a mean amount of residual cylinder of .75DC with a range of 0 to 2.25DC. The mean amount of residual cylinder with the CSI lens was .57 DC with a range of 0 to 1.50DC. The amount of cylinder reduction of the Z6, Mini, Ciba and CSI was .05, .27, .15 and .33DC.

The significance from a paired T-test of the amount of reduction in cylinder from the different lenses is summarized in Table 3. There was a significant reduction in the amount of cylinder from all of the lenses except the Hydron Zero 6. There was significant difference in the amount of cylinder between the Hyron Zero 6 and both the CSI and the Hydron Mini. The Ciba Std. lens showed no significant difference to the Hydron Zero 6. The Hydron Mini lens showed a significant difference to the Ciba lens and no significant difference to the CSI lens. The Ciba lens showed a significant difference to the CSI lens.

The next group of comparisons involves the keratometric cylinder readings. The mean of the keratometric cylinder readings without a contact lens in place was .92DC with a range of .25 to 2.50DC. The mean over keratometric reading on the Hydron Zero 6 was .89DC with a range of .12 to 2.50DC. The Hydron Mini lens over k's mean was .81DC with a range of .12 to 1.87DC. The mean over keratometric reading on the Ciba Std. was .77DC with a range of -.12 to 2.37DC. The CSI lens over k's mean was .87DC with a range of .12 to 2.25DC. The results of a paired T-test on this data showed no significance to any pairing with the keratometry readings.

The last group of comparisons involves spectacle visual acuity and visual acuity with contact lense and a spherical over refraction. The visual acuities were given a decimal equivalent in order to find the mean and compare results. 20/20 was called 1.00, 20/25 was .80, 20/30 was .67, 20/40 was .50 and 20/50 was .40. Plus and minus acuities were taken and graded as the decimal equivalent by dividing the difference between the two lines by the number of letters in that line. The mean spectacle visual acuity was 20/20 with no range(all entering patients had 20/20). The mean visual acuity with the Hydron Zero 6 lens was 20/20-4 with a range of 20/20 to 20/50. The Hydron Mini VA mean was 20/20-4 with a range of 20/20 to 20/30-2. The mean visual acuity with the Ciba Std. was 20/20-2 with a range of 20/20 to 20/40. The CSI had a mean VA of 20/20-3 with a range of 20/20 to 20/40-2. A spherocylindrical over refraction was performed on each lens and had a visual acuity of 20/20-0 with no range.

The results of a paired T-test on the visual acuity data showed a significant difference between the spectacle visual acuity and all of the lenses. The Hydron Zero 6 lens showed no significant difference to the Hydron Mini. There was a significant difference of the Z6 to the Ciba and CSI lens. The Hyron Mini lens showed a significant difference to the Ciba and CSI lens. The Ciba lens showed no significant difference to the CSI lens(see Table 4).

Conclusion: The three lenses being tested all showed a statistically significant reduction in the amount of astigmatism, while the Hydron Zero 6 control lens showed no significant reduction. Clinically speaking, however, the .15 DC reduction by the Ciba Std. lens is probably insignificant. Both the Hydron Mini and the CSI lens corrected greater than .25DC. The mini lens and the CSI lens showed no significant difference between them. The decision to use either of these lenses could be made on other factors such as the thickness and the size differences. The ability to reduce about one quarter diopter of astigmatism easily with a spherical hydrogel lens can be very helpful to the clinician. Depending on the patient, either one of these two lenses could be used on the patients that have between .50 to 1.00DC of astigmatism that is matched by the cornea. The lenses will not completely mask all of the astigmatism, but sufficient vision may be obtained. With a small fitting set of different base curves, patients could be quickly tested for their tollerance to these spherical hydrogel lenses before other avenues are explored.

Keratometry readings showed no significant differences between the before and after measurements. Based on these results, the clinician should not rely on over keratometry readings as a predictor of reduction in residual astigmatism. The reason that these results were not significant was probably due to error in reading, tear fluctuation, and the small central area of the cornea that the keratometer reads in.

Visual acuity showed mixed results in this study. All of the lenses showed a mean significant difference between the visual acuity with a spherical over refraction and the spectacle visual acuity. The mean visual acuity was better with spectacles than with any of the lenses. This change in acuity can be attributed to the residual cylinder because all of the patients were correctable to 20/20-0 with a spherocylindrical over refraction. Clinically speaking, the mean visual acuity of all of the lenses was at least 20/20-4 monocularly. While this sounds like an acceptable level of vision, patients often have vague complaints even with low amounts of residual astigmatism. Repeating this test with a few changes in the visual acuity area would be helpful. First of all, a multiple line 20/20 chart would decrease the learned reponse to that line. Secondly, alternating the order of the lenses would also decrease the likelihood of a learned response. The last variable that could be incorporated would be a low contrast chart to see if there is any change in functional vision with varying amounts of residual cylinder.

This study showed that both the Hydron Mini and the CSI lenses have the capabilty to correct small of amounts of corneal astigmatism. The ease of fitting and low cost of the lenses, compared to the other options, make it an attractive addition to the practitioner's trial fitting sets. When the lenses are used on the right patients with .50 to 1.00DC, the low amount of residual cylinder may be more tolerable than the comfort and stability problems of the rigid gas permeable and hydrogel toric lenses.

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3) Guillon, Michel: Vision with Contact Lenses , ICLC, 1(5):354, 1985.

4) The CSI Sensation - How can Syntex make it happen, Review of Optometry, 46-47, June, 1984.

5) Rich, Georg E., The CSI 13.8 mm Lens: A clinical Study, Contact Lens Forum, 53-62, January 1985.

Table 1

Lens	Thickness	OAD	Power	Base Curve	Material
Hydron Mini	.10mm	13.0mm	-3.00D	8.1,8.3, 8.5,8.7, 8.9	Polymacon 38% (Contains Hema)
CSI	.06mm	13.8mm	-3.00D	8.0,8.3, 8.6	Crofilcon A 38.5% (NO Hema)
Ciba Visitint Std.	.12mm	13.8mm	-3.00D	8.3,8.6, 8.9	Tefilcon 37.5% (Contains Hema)
Hydron Zero 6	.06mm	14.0mm	-3.00D	8.4,8.7, 8.9	Polymacon 38% (Contains Hema)

Table 2

Summary of Statistics

	Cyl.	Cyl. Red.	Keratometry	Visual Acuity
Spectacle	.90DC	0	.92DC	20/20
Hydron Zero 6	.85DC	.05DC	.89DC	20/20-4
Hydron MINI	.63DC	.27DC	.81DC	20/20-4
Ciba Std.	.75DC	.15DC	.77DC	20/20-2
CSI	.57DC	.33DC	.87DC	20/20-3

Table 3

Spectacle Cylinder vs. Residual Cylinder
99% Level of Significance

	Spectacle Cyl.	Z6 CYL	MINI CYL	CIBA CYL	CSI CYL
SPECTACLE CYL	-----				
Z6 CYL	NoSig.	----			
MINI CYL	Sig.	Sig.	----		
CIBA CYL	Sig.	NoSig.	Sig.*	----	
CSI CYL	Sig.	Sig.	NoSig.	Sig.	----

* = Significance 95%

Table 4

SPECTACLE VISUAL ACUITY VS SPHERICAL
CONTACT LENS VISUAL ACUITY
95% Level of Significance

	Spectacle VA	Z6 VA	MINI VA	CIBA VA	CSI VA
SPECTACLE VA	-----				
Z6 VA	Sig.	----			
MINI VA	Sig.	NoSig.	----		
CIBA VA	Sig.*	Sig.*	Sig.	----	
CSI VA	Sig.	Sig.*	Sig.	NoSig.	----

* = Significance 91%