The Effect of the Base Curve to Cornea Fitting Relationship on Lens Flexure and Residual Astigmatism of the Allergan Advent Contact Lens

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ABSTRACT

Studies have shown that fluoropolymer contact lenses have the advantages of high oxygen transmissibility, high oxygen permeability, good wettability, and protein resistance, along with the disadvantage of poor stability. This disadvantage can lead to increased residual astigmatism and visual distortion for patients. This study was designed to evaluate the effects the base curve to cornea fitting relationship has on the flexure and residual astigmatism of the Allergan Advent contact lens. Eighteen subjects, (34 eyes) all having less than two diopters of corneal toricity were fit with three 10.1mm diameter Allergan Advent contact lenses. The lenses were fit 0.50 D steeper than K, on K, and 0.50 D flatter than K. Flexure and residual astigmatism were measured for each fitting relationship in a masked fashion. The results indicate there is very little predictability of flexure and residual astigmatism when fitting the Allergan Advent contact lens. The results give a slight indication that fitting the lens on K, rather than flatter than K, will decrease the amount of flexure and residual astigmatism.

INTRODUCTION

There have been many developments in rigid gas-permeable contact lens materials over the last forty years. These include materials like polymethylmethacrylate (PMMA), cellulose acetate butyrate (CAB), styrene, silicone, silicone-acrylate (SA), fluorosilicone-acrylate

(FSA) and pure fluoropolymers. (Tomlinson, A., 1990)

Recently, there has been an increased interest in the high oxygen permeability pure fluoropolymers have to offer. The need for adequate oxygen for corneal physiology has been the spur to manufacturers to produce materials with more and more oxygen permeability. (Tomlinson, A., 1990) The Allergan Advent contact lens is a good example. The lens is made from a totally new flexible fluoropolymer called fluorofocon A having a Dk of 100. (Kennedy, J., 1989) This material does not contain any silicone and was specifically developed and manufactured for a contact lens by the 3M company. (Kennedy, J., 1989) This flexible fluoropolymer has oxygen permeability superior to even a soft contact lens, but compromises lens stability. (Tomlinson A., 1990) Its highly flexible nature results in lens flexure on the cornea leading to residual astigmatism and visual distortion for the patient.

In addition to high Dk materials, lens parameters responsible for increased lens flexure include center thickness, optic zone diameter, and base curve. The Allergan Advent lens has an average center thickness of 0.18mm, a diameter of 10.1mm, and an optic zone diameter of 8.0mm. Harris et al in a series of papers, concluded that lenses with a center thickness of 0.13mm or less flexed significantly. (Harris, et. al., 1970-72) Pole found that gas-permeable lenses with smaller optic zone diameters (ie. 7.2mm) flexed significantly less than lenses with larger optic zone diameters (ie. 7.8-8.4mm).

In 1983 Pole noted that Polycon lenses fit steeper than K flexed significantly more than Polycon lenses fit on K or flatter than K. (Pole, J., 1983)

This study was designed to evaluate the effect of the base curve to cornea fitting relationship on lens flexure and residual astigmatism using the 10.1mm diameter Allergan Advent contact lens.

METHODS

There were eighteen subjects (34 eyes) in this study. Fifteen subjects (28 eyes) were wearing contact lenses at the time of the study. Keratometry and spectacle refractions were performed on each subject prior to fitting the contact lenses. The predicted residual astigmatism was calculated for each eye. None of the subjects had greater than two diopters of corneal toricity. Table 1 summarizes the data for the subjects.

The lenses used in this study were new diagnostic Allergan Advent contact lenses with the following parameters: 10.1mm diameter, -3.00D power, 8.0mm optic zone, an average center thickness of 0.18mm and a range of base curves from 7.2mm to 8.4mm in 0.10mm increments. The lenses were hydrated and the base curves measured before the study and at several times during the study. There was great care taken in the handling of the lenses due to there high degree of flexibility. Soft lens forceps were used to grasp the edge of the hydrated lens to move it from the case to the radiuscope. Once the lens was placed on the

radiuscope, five minutes were allowed to let the lens normalize on the radiuscope. The examiner then recorded at least three base curve readings for each lens, not knowing which lens was on the radiuscope at any given time. A minimum of three readings were taken for each lens because even with great care in handling, some of the lenses appeared unstable and warped while on the radiuscope. The base curve readings are summarized in table 2.

Lenses determined from keratometer readings to be 0.50 D steeper than K (STK), on K, and 0.50 D flatter than K (FTK) were randomly placed on each eye and allowed to settle for five minutes. The examiner did not know which lens was on the eye to assure a masked study. After the lens had been allowed to settle on the eye the examiner measured lens flexure by taking three keratometry readings over each lens. An average reading nearest 0.12D was determined. A spherocylindrical overrefraction was performed to determine the residual astigmatism.

RESULTS

The findings reveal that flexure and residual astigmatism of the 10.1mm Allergan Advent contact lens is not predictable when varying the base curve to cornea fitting relationship from 0.50D STK to 0.50D FTK in 0.50D increments.

Figure 1 shows the effects the base curve to cornea fitting relationship has on lens flexure of each eye in the study. The

results suggest that on average the lens fit steeper than K flexed more than lenses fit flatter than K and on K respectively. Lenses fit on K flexed the least.

Figure 2 shows the effects the base curve to cornea fitting relationship has on lens flexure and induced residual astigmatism of each eye in the study. The induced residual astigmatism was arrived at by calculating the predicted residual astigmatism and comparing it to the measured residual astigmatism as determined from the overrefraction of each lens. The results suggest the least amount of flexure and residual astigmatism is obtained by fitting the lens on K.

DISCUSSION

The results of the study indicate the base curve to cornea fitting relationship of the Allergan Advent contact lens does not play a very important role in the resultant flexure and induced residual astigmatism. Although the results do suggest, fitting the lens on K rather than 0.50D flatter than K, may slightly decrease lens flexure and residual astigmatism and give better visual results to the patient. These results do not correlate with documented report findings of the effect of base curve on flexure and residual astigmatism with conventional gas permeable materials. Pole found that Polycon lenses should be fit on K or slightly flatter than K. (Pole, J., 1983)

This pure fluropolymer contact lens, unlike all soft and rigid

materials available, demonstrated decreased stability and increased base curve warpage while handling the lens and while on the eye. A large degree of base curve warpage was noted before and during the project. At times the radiuscope mires would distinctly focus at two different base curve readings ninety degrees apart. Kennedy et al suggest this is normal and can be accounted for by adding the first reading to the second reading and dividing by two to obtain the base curve. (Kennedy, et. al., 1989) Our findings did not support this. Sometimes the base curve readings would change without touching the lens even after it settled for fifteen minutes on the radiuscope. Due to these findings, it is suggested that one does not clean or dry the lens before testing, otherwise accurate base curve readings will be unobtainable.

Due to the lenses high degree of flexibility, additional forces such as lid tension, blink force, blink rate, and reflex lacrimation may affect this lens significantly more than a lower Dk, more stable lens. Therefore, it has been suggested by the manufacturers to have a prolonged adaptation period of thirty minutes or more of lens wear prior to lens overrefraction. Our experience, although not practical to the average contact lens practitioner, suggests this same adaptation period, especially if the lenses are not handled properly before insertion.

Our data indicates that on average, the Allergan Advent contact lens flexes more and induces more residual astigmatism when fit

steeper than K than lenses fit flatter than K and on K respectively. However, due to lens instability and lack of predictability it is advised to fit the lens On K.

Table 1: The Refractive Data for Each of The Eighteen Patients (34 eyes).

Patient	Keratometry	Refraction
1.	44.50/175, 45.37/085	-6.75-0.50 X 018
	44.37/170, 45.50/080	-6.25-1.00 X 169
2.	42.75/180, 43.12/090	-0.25-0.25 X 100
	42.37/176, 43.12/086	-0.25-0.25 X 180
3.	44.62/158, 45.50/068	-3.50-0.25 X 106
	45.00/016, 45.37/106	-2.25 sphere
4.	44.50/168, 45.75/078	-4.00-1.00 X 158
	45.00/169, 46.12/079	-4.00-1.00 X 169
5.	43.87/164, 44.25/074	-1.00-0.50 X 095
	43.87/023, 44.37/113	-1.00-1.00 X 079
6.	44.00/149, 44.87/059	-1.50-0.50 X 139
	44.75/139, 44.25/049	-1.50-0.75 X 074
7.	42.75/009, 41.87/099	-6.75-1.25 X 086
	42.75/037, 42.87/127	-7.50-0.25 X 082
8.	45.12/161, 46.62/071	+2.00-1.00 X 162
	45.37/011, 46.12/101	+4.25-0.50 X 078
9.	42.62/155, 43.37/065	-5.75-1.25 X 001
	42.37/010, 43.00/100	-6.00-1.00 X 179
10.	43.75/178, 43.37/088	+1.25-0.50 X 070
	44.00/168, 43.62/078	+1.25-0.25 X 107
11.	43.00/178, 44.62/088	-1.25-1.25 X 180
	42.75/178, 44.62/088	-1.50-1.50 X 180
12.	45.62/146, 45.87/056	Plano-0.25 X 006
	45.75/017, 46.12/107	+0.25-0.25 X 174
13.	44.50/014, 44.87/104	-5.00-0.75 X 025
	44.87/039, 44.50/129	-5.25-0.50 X 099
14.	43.25/003, 43.62/093	-2.50-0.25 X 051
	43.12/166, 43.37/076	-2.50-0.25 X 107

Table 1 continued.

15.	41.50/166, 42.50/076	-4.25-0.50 X 157
	42.12/177, 43.00/087	-4.25-0.50 X 158
16.	42.50/006, 42.75/096	-3.75-0.25 X 066
	42.37/177, 43.00/087	-4.50-0.50 X 021
17.	42.00/020, 42.37/110	+1.25-0.25 X 073
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18.	46.75/029, 45.37/119	-0.75-2.25 X 116
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Table 2

AVERAGE OF BASE CURVE MEASUREMENTS

1. 7.96, 8.06, 8.00, AVG. 8.01 BC: 8.00
2. 7.70, 7.63, 7.66, AVG. 7.66 BC: 7.70
3. 7.70, 7.61, 7.68, 7.70, AVG. 7.67 BC: 7.60
4. 7.46, 7.60, 7.62, 7.54, AVG. 7.55 BC: 7.50
5. 7.96, 7.98, 7.90, 7.93, 7.94, AVG. 7.94 BC: 7.90
6. 8.50, 8.42, 8.40, AVG. 8.44 BC: 8.30
7. 8.25, 8.23, 8.23, AVG. 8.24 BC: 8.20
8. 7.40, 7.60, 7.40, 7.66, 7.55, AVG. 7.52 BC: 7.40
9. 8.15, 8.16, 8.20, 8.19, AVG. 8.17 BC: 8.10
10. 8.42, 8.48, 8.45, AVG. 8.45 BC: 8.40
11. 7.39, 7.39, 7.40, AVG. 7.39 BC: 7.30
12. 7.85, 7.91, 7.88, AVG. 7.88 BC: 7.80

Figure 1
Flexure

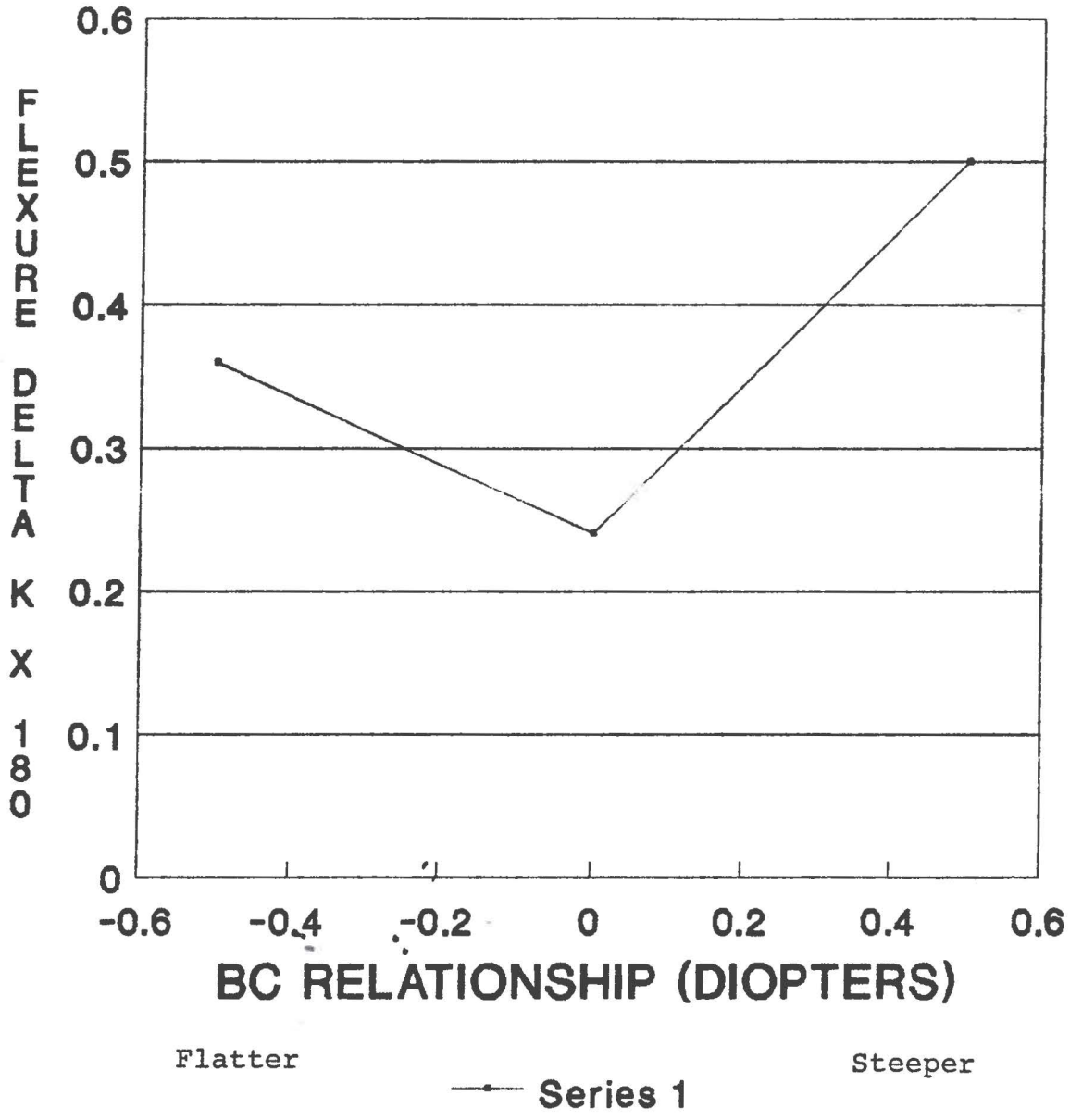
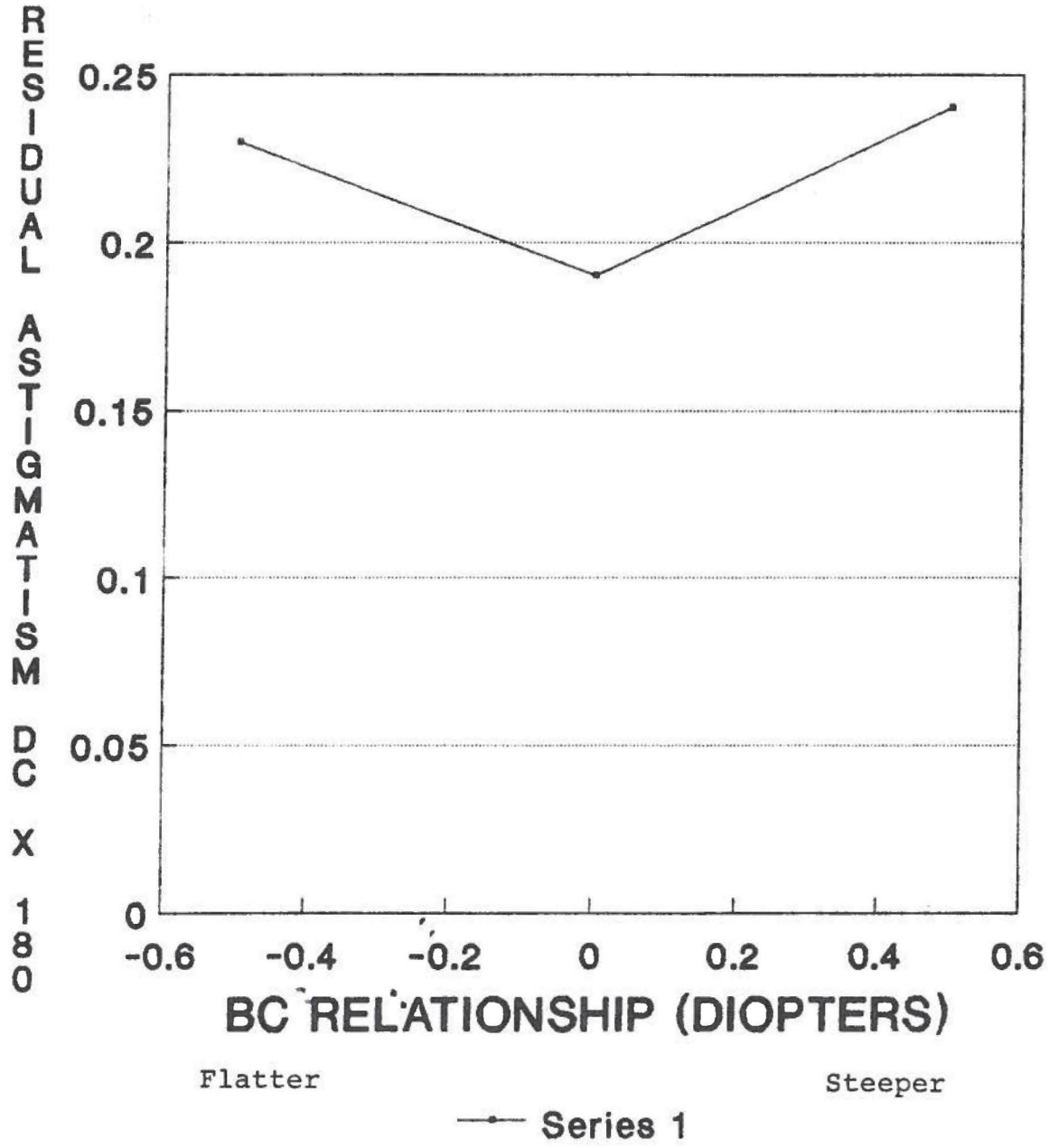


Figure 2
Residual Astigmatism



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