1-1960

The correction of residual astigmatism with toric corneal contact lenses

James E. Vickers
Pacific University

Sanford F. Pelz
Pacific University

The correction of residual astigmatism with toric corneal contact lenses

Abstract

The correction of residual astigmatism with toric corneal contact lenses

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

C. B. Margach

Subject Categories

Optometry

THE CORRECTION OF RESIDUAL ASTIGMATISM WITH TORIC CORNEAL CONTACT LENSES

A Thesis Presented To The Faculty Of Pacific University

In Partial Fulfillment Of Requirements
For The Degree Of Doctor Of Optometry

By
James E. Vickers
And
Sanford F. Pelz

January 1960

ACKNOWLEDGEMENTS

We wish to express our appreciation to Dr. Roy Clunes who provided us with the topic, necessary instructions and advice in order that we might study this area of contact lenses. His outline and consultation have been instrumental in any success we may have achieved.

It is to Dr. C. B. Margach that we express our most grateful thanks for his supervision of this project and guidance in providing a finished paper.

We wish to thank The Plastic Contact Lens Co. and particularly Joe Cinefro, Jr. for their help and ability to be able to provide us with such a lens that we might investigate this problem.

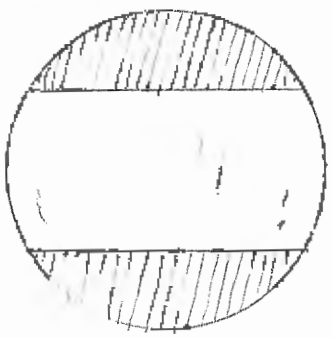
We are also grateful for the cooperation and time given us by those people who were subjects in our study.

INTRODUCTION

One of the problems which exists in fitting of contact lenses by practitioners has been the presence of residual astigmatism. We define residual astigmatism as any astigmatism that we found subjectively with a well adapted contact lens patient wearing his contact lenses. It has been customary to assume that the anterior surface of the cornea is made spherical by the combination of the contact lens and tear layer when a person is wearing his lenses and any astigmatism found is due to one of the refracting surfaces behind the anterior corneal surface or to an irregularity of the retinal surface. However, such assumptions have not offered any new insights into the handling of this problem.

Our investigation of this area has been an attempt to produce a corneal contact lens that will correct residual astigmatism. The subjects we selected all revealed 0.75 D. or more of astigmatism through their spherical contacts. We have attempted to obtain a stable non-rotating toric lens by truncating a round lens in the manner shown in figure 1.

Figure 1.



REVIEW OF PERTINENT LITERATURE

It is Obrig's[1] opinion that the amount of residual astigmatism rarely exceeds 1.25 D. but in one unusual instance it was as much as 6.00 D. An observation by Obrig in fitting scleral lenses was that excessive pressure at the limbus may and can cause what seems to be lenticular (residual) astigmatism.[2] The methods advocated by Obrig for correcting residual astigmatism are relieving pressure at the limbus, prescription of plano cylindrical spectacle lenses for small errors, and grinding the cylinder on the corneal portion of scleral lenses.[3]

With the advent of corneal lenses and their many advantages over the scleral lens, practitioners now have the problem of patients who have shown a substantial or annoying amount of residual astigmatism which produced lowered visual acuity and discomfort.

Two types of toric lenses are available to the contact lens practitioner. The convex toric surface lens is the only one which is designed to correct residual astigmatism.

a. Concave Toric Surface: The idea of a toric corneal lens was presented as early as 1953.[4] The lens in the shape

1. Obrig, CONTACT LENSES, 1st Ed. 1942, p.48
2. Idium p.248
3. Idium p.48
4. Schapero,Max, THE FITTING OF HIGHLY TORIC CORNEA WITH TORIC CORNEAL LENSES, Am. J. Optom. and Arch.,30(3): 157-160, March 1953.

of a "Univis R" segment was fitted on "highly toric" corneas. The posterior surface of this lens was ground in a toric surface and thereby provided a better fitting lens with less rocking. In 1959 one of the manufacturers[5] of contact lenses presented a toric lens (Ultracon[t] Cylindrical Bevel Lens) to fit those patients with 3.00 D. or over of corneal astigmatism.

The above lenses were not aimed at correction of residual astigmatism but to provide a better fitting lens.

b. Convex Toric Surface: Another manufacturer[6] developed in 1959 a toric truncated corneal lens (TORCON) with the toric surface on the anterior side for the correction of residual astigmatism. This is the same type of lens that we have used in our investigation.

PROCEDURE

We selected from patients currently receiving care at the Pacific University Optometric Clinic those cases that revealed .75 D. or over of residual astigmatism. Any under this amount we arbitrarily considered tolerable by

5. Kontur Kontact Lens Co., Richmond, Calif.
6. The Plastic Contact Lens Co., Chicago, Ill.

the patient. We provided a special examination and fitted each of these patients with one of our truncated lenses. The examination included the following:

1. V.A. through spherical contacts; Compared with v.a. through toric contacts for evaluation of improvement.

2. #7a through contacts and V.A.; This was a B.V.A. which gave the prescriptable cylinder.

3. #7a without contacts and V.A.; Same as 2 above but without contacts.

4. "K" reading; Taken on removal of spherical contacts. (Not applicable to our study but taken to obtain data for other research.)

5. Comfortable wearing time of spherical contacts.

6. "K" before contacts; Taken from case records where possible or verification of previous spectacles.

7. Specifications of spherical contacts; Actual measurement of base curve, thickness, size, power, and bevel were made with radiuscope, lens measure, lensometer and measuring magnifier in verification of prescription data.

8. Measurement of total fissure and lower lid to center of pupil; This measure was made with the eyes in the primary position with normal illumination.

9. Diameter of the cornea; Measured as in 9 above in the 180th meridian to determine the maximum finished lens size that we felt would be acceptable by the patient. However, we ordered lenses larger than this measure to allow

for finishing and polishing reduction in size. Also, if the lens were too large we could reduce the size until we obtained patient comfort.

Toric lenses were then ordered in uncut form. The determination of the specifications of the prescribed lenses was as explained below.

1. Type: Tricurve lenses were initially prescribed due to the large size we fitted. However, bicurve lenses were sent from the lab and adjustment made by us for three of the cases studied.

2. Base Curve: Fitted "on K" (same as base curve of spherical contacts.)

3. Intermediate (2nd) Curve: 0.50 mm. flatter than base curve.

4. Thickness: Standard.

5. Size: Ordered larger than diameter of cornea. This was desired to obtain maximum contact with cornea and aid in correction of lens rotation. The theory of this will be explained in the next section under lens modification procedure.

6. Optical Zone: Arbitrarily 8.00mm. which we assumed to be adequate.

7. Power: Determined by adding the power of the spherical contacts to the #7a thru contacts in plus cylinder form. Power of spherical contacts + #7a thru contacts in plus

cylinder = power of toric contacts.

a. Modification of Uncut Toric Lens: The following steps were accomplished in modification of the experimental contact lenses.

Step 1, Axis; We used the lensometer to "spot" the plus cylinder axis of the experimental lens. The location of that axis in the truncated lens having already been determined by our examination, we marked "the 180° line" while holding the lens in the lensometer. Marking was completed on the standard spectacle lens layout protractor as shown in figure 2.

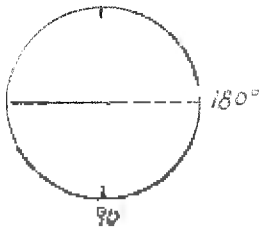


Figure 2

Step 2, Mount lens; The contact lens was securely mounted concave side out on a steel mandrel held by mastic tape as in figure 3.

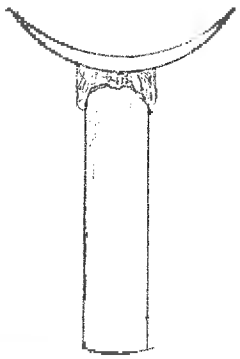


Figure 3

Step 3, Cutting Procedure; The first cut was made on the flat portion of the 60° stone, figure 4. The 90° meridian was reduced equally on top and bottom giving 1½ to 2 mm. difference between

horizontal and vertical meridians. Care was maintained to keep the upper and lower cut parallel to the 180° line on the lens.

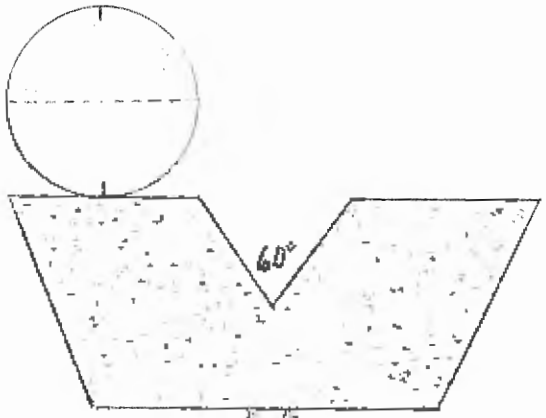
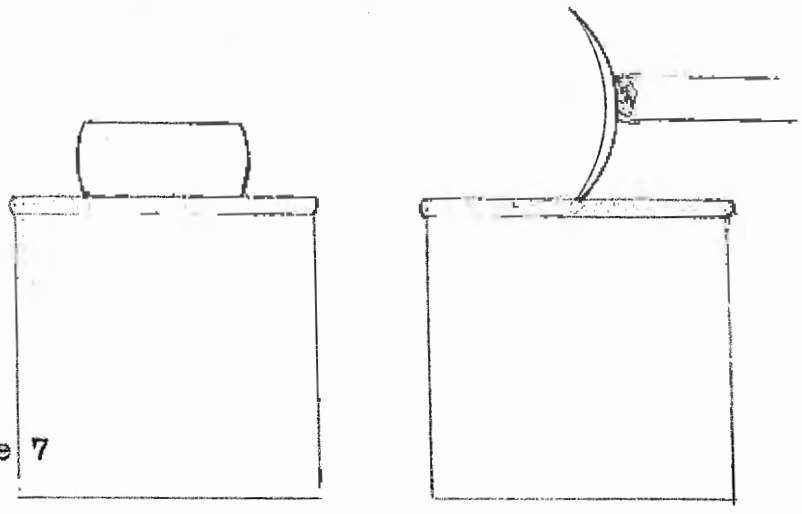


Figure 4

Step 4, Bevel and Polish Sequence; The round beveling stone, 12.25mm., was used to make a .5mm. to .6mm. peripheral curve. To polish this curve a 11.50mm. polishing tool was used followed by a 9.25mm. blending tool.

Step 5, Edge Treatment; The round sides of the lens were polished with the "conish" instrument. The flat edge was polished by holding the lens perpendicular to the 180° flat polishing tool, figure 5. The back edge of each straight surface was polished with a steeper than base curve tool to get into the inner edge of the flat cut. Example: With a base curve of 8.00mm. we used a 7.50mm. tool.

Figure 5



We polished the front surface of the flat edge by varying the angle of the "Forcon" lens on the 180° polishing tool. The lens was then inspected under the binocular microscope of the universal slit lamp to insure smoothness of all surfaces and edges.

b. Theory of Design: Our "Forcon" lenses were constructed to be large in size, thicker than average edge thickness, flat on the top and bottom, firm fitting, and with abrupt angles between the rounded and flat surfaces.

The lens was constructed large because we believed that the larger the lens the less rotation. The thick edge was desired to provide correction of the movement the lens made when in contact with the lower lid. Further, we theorized that by keeping the top and bottom of the lens straight, the lens edges would ride on the lower lid and prevent the lens from rotating off axis. Tightness was secured by having the lens large and fitting "on K".

Position (non-rotation) of the lens was presumed to be maintained by two means. First, if the lower lid contacted one of the angles, the contact lens was pushed up allowing the opposite side to lower and thereby maintaining the desired axis as shown in figure 6. As the lens dropped, the force would be to allow the high corner to drop to the lid once the other

lower angle was in contact with the lower lid. Second, rotation would be halted when the aurupt angle of the lens

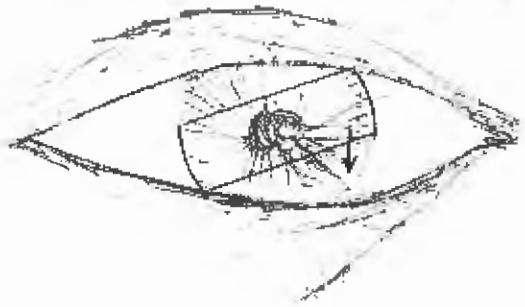


Figure 6

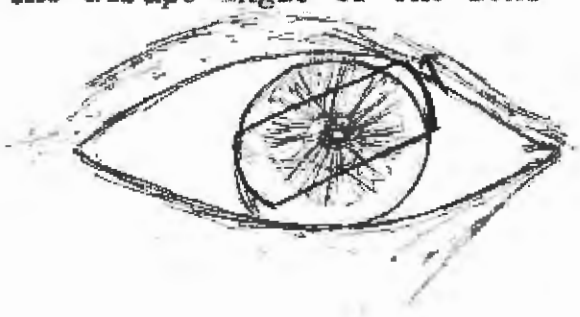


Figure 7

"dug into" the sclera due to the steeper curve of the lens. This correction would be most effective on the superior scleral region when the lens was raised by the upper lid as shown in figure 7.

The aurupt angle and straight edge were assumed to yield faster correction than would a rounded edge.

c. Individual Case Data: Each case studied including findings, observations, and adjustments of lenses as indicated is presented on the following pages.

Name K.B.

"K" Before Contacts: OD [illegible]
OS 45.37@180;44.87@90

Rx Before Contacts: OD [illegible]
OS 4.87-1.00x165

7a Thru Contacts: OD [illegible] V.A. OD 20/15
OS 4.75-1.00x180 OS 20/15
OU 20/15

7a Without Contacts: OD [illegible] V.A. OD 20/15+
OS 4.87-1.00x165 OS 20/15+
OU 20/15+

"K" Reading: OD [illegible] V.A. thru Spherical Contacts.
OS 45.75@180;45.00@90 OD 20/40
OS 20/40
OU 20/30-2

Comfortable Wearing Time:

Specifications of Spherical Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	Spheroscon	7.75		9.2		+1.25	.5mm.
OS	Spheroscon	7.75		9.2		+1.12	.5mm

Center of Pupil to Lower Lid: 6mm
Total Fissure: 12mm
Diameter of Cornea: 12mm.

Specifications of Unout Toric Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	Toricone	7.75	8.01	ave.	12mm	8.00	+1.00x1.00
OS	Toricone	7.76	8.28	ave	12mm	8.00	[illegible]

Specifications of Finished Lenses:

	Power	Size	Thickness
OD	+1.00x1.00x75	12.1x9.6mm	ave.
OS	Rejected, because of physical imperfection.		

Specifications of Final Lenses :

OD	+ 1.00+ 1.00x165	11.6mm. x 9.6mm.
OS	+ .87 + 2.00x 80	11.6mm. x 9.6mm.

The first pair of lenses arrived in bicurve form and were returned to the lab to have the intermediate curve added. The addition of this curve produced extremely thin lenses with paper like edges. Due to the thinness the left lens was cracked on arrival. The right lens was modified and upon fitting we found the #7a to be + .75 - 1.25 X 36. Verification of this lens was + 1.00 + 1.00 X 15. We had mistakenly mounted the cylinder off axis. The patient reported little discomfort due to the lens. Rotation of the lens was not more than 10 to 15°. The size of this lens was 12.1mm. X 9.9mm.

A new pair of lenses were ordered as per the previous specifications. They were received in bicurve form. The finished size of the lenses was 11.2mm. X 9.5mm. Because of the lack of an intermediate curve, we blended them well (2 - 3 min. at high speed). Upon insertion the patient complained of discomfort. The right lens rotated as much as 25° but usually was on axis with less rotation. The left lens was unstable and sometimes rotated 90° off axis. V.A. was sustained at 20/15 O.D. but varied in the O.S. When the left lens was held on axis the acuity was also 20/15. Both lenses touched the limbus on both the nasal and temporal side. It was this limbal touch which we attributed as the cause of

the discomfort. Because of this the adjustment indicated was to reduce the size of the lenses in the horizontal meridian.

The reduced size was O.D. 10.7mm. X 9.5mm. and O.S. 10.8mm. X 9.5mm. This modification produced an oval lens. Upon insertion the patient complained of discomfort. We inspected the lenses and noticed sharp edges. The edge treatment was repeated and the top and bottom recut to give straight edges instead of oval. This modification produced comfortable lenses which were within the limbal area. The right lens was usually on axis and would only rotate about 10^{o} when the patient blinked and then it would settle back to position. The lower edge of the lens was well above the lower lid when the patient looked straight ahead. The left lens was unstable and off axis about 10^{o} to 25^{o} most of the time. V.A. was blurred most of the time. If the patient did not blink and let the lenses settle or if he squinted and forced the lenses on axis using the lower lid then the acuity would improve to O.D. 20/20, and O.S. & O.U. 20/15, but the letters were not sharp and clear. The reason for this was found in the refraction which was O.D. -.75 - 1.25 X 37½ and O.S. + .25 -.75 X 160. We thought that adaption and settling of the lenses would eliminate this problem so we instructed the patient to wear the lenses 2 or 3 hours each day.

The following exam revealed the same finding as did the previous check. The lenses were again verified to be sure they were in the proper eyes. The fluorescein pattern indicated that both lenses were tight. The astigmatism we found thru the "torcons" was about the same as the spectacle correction the patient was wearing. Because of this we wanted to recheck the refraction thru the spherical contacts to see if additional cylinder was also indicated.

The exam thru the spherical contacts gave an unaided v.a of O.D. & O.S. $20/20^{-2}$ and O.U. $20/20^{+2}$. This was an increase of acuity from that previously found. The letters were not clear but were oblique and double. The refraction was O.D. +.50 -.50 X 60 and O.S. + 1.25 - 1.25 X 120. This was a reduction in the astigmatism of the left eye only.

In this case the astigmatism was not reduced and the problem of rotation was not corrected in the O.S. The only success we had was in attaining patient comfort and a stable lens O.D.

Due to the uncorrected cylinder the factors to be considered in adjustment were tightness and proper prescription of the power of the cylinder.

Name L.E.

"K" Before Contacts: OD [illegible]
OS 45.50@180;44.37@90

Rx Before Contacts: OD [illegible]
OS -4.12-.75x140 20/20

Rx Thru Contacts: OD [illegible] V.A. OD 20/20
OS pl+1.00x120 20/15 OS 20/15
OU 20/15

Rx Without Contacts: OD [illegible] V.A. OD
OS -5.00-1.00x65 OS
OU 20/20

"K" Reading: OD [illegible] V.A. thru Spherical Contacts.
OS 45.75@180;44.62@90 OD 20/30
OS 20/15
Comfortable Wearing Time: All day. OU 20/15

Specifications of Spherical Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	Polycon	7.85	8.35	.08	10.5		-2.62
OS	Tricurve	7.75	8.25	.08	10.5		-2.75

Center of Pupil to Lower Lid: 6.5mm
Total Fissure: 10.0mm
Diameter of Cornea: 11.5mm

****

Specifications of Thank Tank Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	Tricurve	7.85	8.35	.08	14mm	8.00	-3.62x1.00 180 .5
OS	Tricurve	7.75	8.25	.08	14mm	8.00	-4.25x1.00 180 .5

****

Specifications of Finished Lenses:

	Power	Size	Thickness
OD	[illegible]	[illegible]	
OS	[illegible]	[illegible]	

This patient had previously worn contacts but due to the residual astigmatism and the hyperphoria was unable to continue due to suppression and monocularity.

The lenses were received in bicurve form and returned to the lab to have the intermediate curve added.

Due to the vertical prism these lenses have a top and bottom and must be inserted that way. The initial size of the lenses was O.D. 13mm. X 10.4mm. and O.S. 13mm. X 11.2. Upon first inserting, rotation was never more than 15° in either eye. The lenses extended beyond the limbus and encroached upon the sclera about 1mm. on each side. The lenses were uncomfortable and couldn't be worn more than two hours. The patient reported better acuity than with his other contacts. The indicated adjustment was to reduce the size to provide patient comfort.

The reduced size was 11.5mm. X 10mm. O.D. and O.S. which provided a lens that was equal to the horizontal diameter of the cornea.

The first week the patient could not wear the lenses more than 3 hours. V.A. was 20/20 O.D. and 20/15 O.S. The lenses maintained the desired position except on initial insertion the left lens would sometimes rotate 90°. This was attributed to the slight tearing upon first inserting and also to the heavy base up prism which desired to become base down. We theorized that this might happen and were aware

that the base down prism would offer more stability but we wanted to find out the result if base up were used. The patient manipulated the lens back to base up and by fluttering his lids could maintain position of the lens if it started to rotate. Within a few minutes after insertion the lenses became stable.

Refraction through these lenses was O.U. +.75 -.50 X 90 with v.a. of 20/20 O.D. and 20/15 O.S.

By the second week all day wearing time was accomplished. The patient has been wearing the lenses for 4 weeks now 10 - 12 hours per day. Rotation of the lenses was not more than 10°. The only complaint was of fogging which started after wearing the lenses 6 hours but decreased as they were worn longer. This indicated a slightly tight lens and needed to be blended. The patient had been removing the lenses during the dinner hour and reinserting after to eliminate this fogging problem.

In regard to the hyperphoria, the following findings were taken. #12 (Vertical phoria @ distance) was 3 Right Hyper. Visual Skill cards showed a $\frac{1}{2}$ Right Hyper far and near. Stereopsis (3° fusion) was very good. Alternate cover showed only a slight vertical jump to the patient.

This case shows the possibilities of such a lens as we have worked with. Patient comfort was attained. Position of the lens was stable (non-rotation). V.A. was improved. Although the residual astigmatism was not eliminated, it was reduced. This indicates to us that more cylinder should be prescribed than that amount measured 15mm. away from the anterior surface of the cornea.

Name E.P.

"K" Before Contacts: OD Unavailable
OS Unavailable

Rx Before Contacts: OD Unavailable
OS Unavailable

Rx Thru Contacts: OD [illegible] V.A. OD 20/15
OS [illegible] OS 20/15
OU 20/15

Rx Without Contacts: OD [illegible] V.A. OD 20/15
OS -2.00-1.50x180 OS 20/15-4
OU 20/15

"K" Reading: OD [illegible] V.A. thru Spherical Contacts.
OS 39.25@175 41.25@85 OD 20/30
OS 20/20-
OU 20/20-

Comfortable Wearing Time: All day.

Specifications of Spherical Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	[illegible]	8.25	8.75	.25	9.0		-1.75 .5mm
OS	Bicurve	8.90	9.40	.21	8.9		-1.25 .5mm

Center of Pupil to Lower Lid: 7mm
Total Fissure: 10mm
Diameter of Cornea: 12mm

Specifications of Unmet Toric Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power Bevel
OD	[illegible]	8.25	8.75	.25	13mm	8.00	-5.25x175
OS	Tricurve	8.90	9.40	.25	13mm	8.00	-1.75x175

Specifications of Finished Lenses:

	Power	Size	Thickness
OD	-5.25x175x170	13.2x9.6mm	
OS	-1.75x85x170	13.2x9.6mm	

* These lenses were received in Bicurve form, because of lack of intermediate curve we blended them.

Upon initial insertion the lenses were comfortable. The fluorescein pattern showed tightness of the intermediate curve on the nasal and temporal sides. The left lens rotated as much as 90° but the right lens never rotated over 10°. The refraction was O.D. plano -.50 x 20 and O.S. + 1.25 sphere with an undetermined cylindrical component due to the unstable lens. The acuity was O.D. 20/15, O.S. 20/80 and O.U. 20/15. The patient continued wearing the lenses.

A recheck was taken a week later. Again the left lens rotated 90° and right lens was stable. The refraction was O.D. plano and O.S. + 1.25 with an undetermined cylindrical component due to the excessive rotation. The V.A. was 20/15 O.D., 20/40 O.S. and 20/15 O.U. The patient complained after wearing the lenses 12 hours of the right eye fogging and a spectrum effect when looking at lights. The fluorescein pattern of the right eye indicated a tightness of the intermediate curve. The adjustments made were to open the intermediate curve of the right lens and cut the nasal and temporal sides of the left lens so that the edges would be within the limbal area. The size of the left lens was then 11.6mm. x 9.9mm.

The following week the patient complained of sharp edges. The edges were checked and polished. The refraction was O.D. plano, O.S. + 1.25 with unmeasureable astigmatism. Rotation had not decreased in the left eye. The right lens still sustained the proper position. Upon instructing the patient to wear the lenses for 8 hours instead of 12, the symptoms of fogging in the right eye were eliminated. When the left lens was held on axis the v.a. increased from 20/40 to 20/20.

In this case we increased the v.a., eliminated the astigmatism and attained a stable lens in the right eye only. In regard to the left lens the failure might have been contributed to the fact that it fit more loosely than the right lens. This might have been caused by our using the 9.25mm. blending tool on both lenses and not considering the difference in base curve of each lens. Usually the intermediate curve is .50 D. (.20mm. equals 1.00 D.) flatter than "K". Using the 9.25mm. curve in combination with the 8.23mm. base curve of the right lens we had a tight fitting lens. However, the 9.25mm. curve on the left lens was .35mm. flatter than the base curve. We do not believe this offered as tight a fitting lens. The looser fit of the O.S. lens compared to the O.D. lens was also confirmed by the fluorescein pattern.

Name L.R.W.

"K" Before Contacts: OD 42.25x180;42.50x90
OS 42.25x180;42.50x90

Rx Before Contacts: OD -1.75-1.00x90
OS -1.50-1.00x90

7a Thru Contacts: OD -1.00-1.00x90 V.A. OD 20/15
OS -1.00-.75x90 OS 20/15
OU 20/15

7a Without Contacts: OD -1.50-1.50x90 V.A. OD 20/15
OS -2.00-.75x90 OS 20/15
OU 20/15

"K" Reading: OD 41.87x180;41.62x90 V.A. thru OD 20/70
OS 41.87x180;41.50x90 * Spherical OS 20/60
Contacts. OU 20/60

Comfortable Wearing Time : Undetermined due to low V.A.

Specifications of Spherical Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power	Bevel
OD	Bisurve	7.95		.20	9.2		-1.00	.4
OS	Bisurve	7.92		.21	9.2		-1.00	.4

Center of Pupil to Lower Lid: 5mm
Total Fissure: 10.5mm
Diameter of Cornea: 12.0mm

.....

Specifications of Uncut Toric Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power	Bevel
OD	Trisurve	7.95	8.45		12.0mm	8.0	-3.00x 1.00	
OS	Trisurve	7.92	8.42		12.0mm	8.0	-2.75+ .75	

Specifications of Finished Toric Lenses:

	Type	Power	Size
OD	Trisurve	-3.00x1.00x90	11.5x10.6
OS	Trisurve	-2.75-.75x180	11.6x9.8

Specifications of re-ordered lens:

	Type	Power	Size
OD	Bisurve	-3.00x1.00x180	11.8x10.0mm
OS			

* Addition of more minus in spherical contacts to OD-1.62 ;OS -2.00 gave V.A. of OD 20/30 and OS 20/20-2.

Upon the insertion of the first pair of lenses the patient was quite comfortable. The fluorescein pattern signified a slight touching in the intermediate area of both eyes. The left lens rotated 90° once, but when the gaze was shifted up the lens positioned properly. The right lens continually rotated 90° with blurring when in position but clear when off axis 90°. The reason for the reduced v.a. was that we had mounted the right lens 90° off axis. The V.A. in the right eye was 20/15 when on the proper axis and was quite reduced when rotated 90°. The V.A. in the left eye was 20 /15^{-2} and O.U. 20/20^{+2}. The patient reported that when the "Torcon" lenses were properly positioned her acuity was better than with the spectacles or spherical contacts she had been wearing. The patient was told to wear the lenses a couple hours each day. She did this to determine if adaption would decrease the amount of rotation.

A week later the rotation of the right lens was still excessive while the left lens never rotated over 20° or 30°. V.A. was O.D. 20/40 when off axis and 20/15 when on axis, O.S. was 20/20 to 20/30.

A new right lens was prescribed which we received in bicurve form. The modified size was 11.8mm. x 10.0mm. The lens was blended well due to the lack of an intermediate curve. The patient then inserted the lenses at which time

she complained that the left lens felt slightly scratchy. She could not feel the right lens. The right lens demonstrated as much as 90° of counter-clockwise rotation while the left lens rotated up to 45° in a clockwise direction. The refraction was O.D. plano - .50 X 75 and O.S. -.25 -.25 X 180 giving a V.A. of 20/15^{-3} O.D., O.S. and O.U. The unaided V.A. was O.D. 20/20^{+3} when the lens was positioned correctly, O.S. 20/15^{-2} and O.U. 20/20*. The OU. acuity showed alternate clearing and blurring but was clear more times than not.

Due to our inability to eliminate the rotation we did not achieve any sustained improved acuity. However, we did provide a large comfortable lens which gave improved acuity when in the proper position. The unstable lens could have been due to an improper fit, a smaller than optimum size, or because of the near spherical cornea.

Name B.F.

"K" Before Contacts: OD [illegible]
OS 42.12@180;42.25@90

Rx Before Contacts : OD [illegible]
OS -.50-.50x100

Rx Thru Contacts: OD [illegible] V.A. OD 20/15
OS -.75-.75x105 OS 20/15
OU 20/15

Rx Without Contacts: OD [illegible] V.A. OD 20/15
OS -.25-.75x105 OS 20/15
OU 20/15

"K" Reading: OD [illegible] V.A. thru Spherical
OS 42.12@180;42.25@90 Contacts. OD 20/25
* OS 20/30
OU 20/40

Comfortable Wearing Time: 10 hrs.

Specifications of Spherical Contacts:

	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power	Bevel
OD	Spherocon A	8.06		.11	9.8		-.50	
OS	Spherocon A	8.01		.10	9.2		pl	

Center of Pupil to Lower Lid: 5mm
Total Fissure: 10mm
Diameter of Cornea:

****

Specifications of Unout Toric Contacts:

-	Type	Base Curve	2nd Curve	Thickness	Size	Optical Zone	Power	Bevel
OD	Toricurve A	8.06	8.66	.xxx	13mm	8.00mm	-1.50@75	
OS	Toricurve	8.01	8.51	.xxx	13mm	8.00mm	-1.50@75	

****

Specifications of Finished Lenses:

	Power	Size	Thickness
OD	[illegible]	13.0x10.5mm	
OS	-1.50@75x15	13.0x10.5mm	

* V.A. improved to 20/20- with more minus in spherical contacts.

- These lenses were received in bicurve form. They were modified and blended well.

The symptomatology of the patient was one of discomfort when fitted. The fluorescein pattern showed tightness of the intermediate area. The vertical section of the lens protruded onto the sclera. This indicated need for reduction of the vertical size about 1½ mm. The refraction was pl -.50 ∧ 30 O.D. and plano O.S. The V.A. was $20/20^{-1}$ O.D., $20/18^{-2}$ O.S. and $20/15^{-1}$ O.U. There was slight counterclockwise rotation in both eyes. The lenses could not be worn more than 2 hours the first week. We adjusted the two lenses by opening the peripheral curve to relieve the tightness with the 12.25mm. stone and cutting the vertical section down so as to get away from the scleral touch. The reduced size was O.D. 12.1mm. ∧ 9.3mm. and O.S. 12.0mm. ∧ 9.3mm.

In the next exam a week later there was no lens rotation of any degree. There was tearing and discomfort inflicted from wearing the lenses. The fluorescein pattern showed a slight tightness in the intermediate area of the right eye. The O.S. pattern indicated a "firm" fit. The acuity had improved in the right eye to $20/15^{-1}$ O.D. and the O.S. & O.U. were still $20/15^{-1}$. The refraction was O.D. pl -.50 ∧ 135 and O.S. plano. The only complaint of the patient was that when she shifted her gaze from the primary position she was uncomfortable and began tearing. She remarked that she became a "head mover" as opposed to an "eye mover".

A week later the acuity was 20/15 O.D., O.S. and O.U. The refraction was O.D. plano -.50 X 135 and O.S. plano. She was still unable to perform comfortable eye movements.

The last refraction was O.D. plano -.50 X 120 and O.S. + .25 -.25 X 110. The acuity was $20/15^{-3}$ O.D., O.S. and O.U. There was no lens rotation in the O.D. and under 10^{o} rotation in the O.S. The patient complained of irritation of the lower lid and discomfort when moving her eyes side to side. The lid irritation indicated a sharp edge and need for polishing of the straight edge. The discomfort inflicted upon eye movements indicated a need for adaption or possibly slight reduction of size.

In this case the acuity was substantially improved, rotation was negligible (position sustained), and astigmatism reduced. We feel that the discomfort factor is minor in comparison to achieving a non-rotating lens and could be eliminated with continued modifications.

DISCUSSION

The problems of fitting truncated toric lenses were patient comfort, sustained b.v.a., elimination of astigmatism and stability of the lens.

The most difficult of these to establish was the non-rotating lens. We were successful in fitting a stable lens in most cases. A stable lens was fitted both in tricurve and bicurve form, however, we found that the bicurve lens was in most cases a tighter lens.

Visual acuity was improved in all cases when the lens was in the proper position. This v.a. was sustained only if the lens was stable.

Full cylinder of the #7a thru spherical contacts was prescribed. The astigmatism was not completely corrected in most cases by this prescription. As the toric lenses were worn longer periods however, these astigmatisms tended to decrease. Therefore, we feel that with adaption and the prescription of more cylinder than originally found, the residual astigmatism could be eliminated, providing the lens was stable.

Patient comfort can be obtained by proper polishing and selection of size of lens used.

In general the smaller lenses (those that were further within the limbal area) tended to rotate more. This indicated that a large lens (equal to the corneal diameter or larger) should be fit and adjustment made to provide patient comfort.

Because we improved acuity and achieved comfort in most cases we feel that the prescription of "Torcon" lenses would be practical as a means of correcting residual astigmatism. However, the practitioner should be aware of the problems involved and not discouraged by individual cases which are not initially successful. There is much that remains to be learned before the confidence of successful fitting increases.

Recommendations for further study in providing correction of residual astigmatism are:

1. Size of lens: We believe that .1mm. variation in size can be the difference in success or failure in providing a stable lens.

2. Variation of base curves and intermediate curves.

3. Effect of varied bevels.

4. Shape of lens.

5. Combination of concave toric surface and truncated lens on astigmatic corneas to prevent rotation.

CONCLUSIONS

1. Residual astigmatism can be reduced or eliminated with toric corneal contact lenses.
2. The acuity of contact patients with residual astigmatism can be improved with a non-rotating toric lens.
3. The dimensions of the toric lens are very important in achieving stability.
4. A truncated lens provides a more stable lens than a round lens.
5. A tight fitting lens is apt to be more stable than a loose lens.
6. Large truncated toric lenses can be worn all day with comfort.
7. Success in producing a non-rotating lens can not be said to depend upon any single factor.
8. In most cases some amount of astigmatism was found thru the toric lenses (residual residual astigmatism). Such cases indicate a need for prescribing more cylinder than found thru the spherical contacts.
9. A stable lens can be fitted on both spherical and astigmatic corneas.
10. Prism base up can maintain position in contact lenses.

SUMMARY

This experiment was an attempt to correct the residual astigmatism of 5 subjects who had .75 D. or over of astigmatism, through their spherical contact lenses. Convex toric surface lenses were truncated and fit on each subject. The significant findings and results are shown in Table 1.

A detailed discussion of the handling of each patient in the study is included, including the mechanical changes made during the fitting period.

In regard to Table 1; In those cases where the lens was unstable the wearing time was undetermined due to the lowered v.a.

TABLE I

	K.B.	L.H.	E.F.	L.V.	B.F.
GROSS CORNEAL ASTIGMATISM	O.D.-1.50X180 O.S.-1.50X180	-.50X180 -.87X180	-1.87X180 -2.00X175	-.12X180 -.25X180	-.37X180 -.12X180
ASTIGMATISM #7a WITHOUT CONTACTS	O.D.-1.25X25 O.S.-1.00X165	-1.50X95 -1.00X95	-.25X165 -1.50X180	-1.50X92 -.75X90	-.75X85 -.75X95
ASTIGMATISM WITH SPHERE CONTACTS* *	O.D.-1.00X75 O.S.-1.00X120	-1.00X90 -1.00X110	-.75X80 -.75X80	-1.00X90 -.75X90	-.75 X75 -.75 X105
V.A. WITH SPHERICAL CONTACTS	O.D. 20/40 O.S. 20/40	20/30 20/15	20/30 20/20-	20/30 20/20-2	20/ 20+ 20/ 20-
TORCON WEARING TIME	O.D. Undetermined O.S. "	All Day * All Day *	AllDay * Undetermined *		2hours 2 "
TORCON V.A.	O.D. 20/15 O.S. 20/15	20/20 20/15	20/15 20/20-40	20/15&blurr 20/20-30	2 0/15 2 0/15
TORCON ASTIGMATISM	O.D.-1.25X37 O.S.-.75X160	-.50X90 -.50X90	Negative Undetermined	-.50X75 -.25X180	-.5 0X120 -.2 5X110
TORCON LENS ROTATION	O.D. 0-10° O.S. 25°	0-10° 0-10°	0-10° Unstable	Unstable "	0 - 5° 0 - 5°

* Undetermined due to lowered v.a.
** This cylinder was prescribed in the "Torcons".