A study of the effects of progressively flattening the peripheral curve in contact lenses while maintaining all other dimensions constant

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A study of the effects of progressively flattening the peripheral curve in contact lenses while maintaining all other dimensions constant.

Abstract
All of the subjects had worn contact lenses successfully for more than six months prior to the thesis work, many as long as six or eight years. Any subjective or objective symptoms differing from those prior to wearing the research lenses could have been considered the consequence of the new lenses. Many fitting problems can be overshadowed by normal adaptive symptoms, and thus, go unnoticed for a period of time, interfering with the subjective evaluation of the lenses. Given a contact lens with the same specifications as those presently worn, (viz. optical zone radius, optic zone width, center thickness, power, peripheral curve width, and overall lens size), is there a peripheral curve radius, as determined subjectively and objectively, that seems to be ideal for the subject?

Degree Type
Thesis

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A STUDY OF THE EFFECTS OF PROGRESSIVELY FLATTENING THE PERIPHERAL CURVE IN CONTACT LENSES WHILE MAINTAINING ALL OTHER DIMENSIONS CONSTANT.

BY

EDWARD H. KOSNOSKI

DENNIS K. LANGSTON

Submitted in partial fulfillment of the requirements for the Doctor of Optometry degree in the College of Optometry, Pacific University, May, 1968.
ACKNOWLEDGEMENTS

Our gratitude is extended to Doctor Donald C. West, Professor of Contact Lenses, Pacific University College of Optometry, under whose direction this study was conducted and to Precision Cosmet Company in Portland, Oregon for loaning a peripheral curve modification unit which aided in making more uniform peripheral curves, therefore, making the data more reliable.
PROBLEM

All of the subjects had worn contact lenses successfully for more than six months prior to the thesis work, many as long as six or eight years. Any subjective or objective symptoms differing from those prior to wearing the research lenses could have been considered the consequence of the new lenses. Many fitting problems can be overshadowed by normal adaptive symptoms, and thus, go unnoticed for a period of time, interfering with the subjective evaluation of the lenses.

Given a contact lens with the same specifications as those presently worn, (viz. optical zone radius, optic zone width, center thickness, power, peripheral curve width, and overall lens size), is there a peripheral curve radius, as determined subjectively and objectively, that seems to be ideal for the subject?
INTRODUCTION

Many methods of fitting the peripheral curve in contact lenses have been advocated. Some use the peripheral curve to aid in the stability of the lens and others use it simply for venting purposes.

Doctor Robert J. Morrison suggests the use of a constant peripheral curve for most lenses coming from his laboratories, and does not depend upon the peripheral curve, but the base curve and the overall size of the lens for the stability in his fitting philosophy. By using trial lenses the stability and fitting characteristics are evaluated by arbitrarily changing the base curves and/or size in order to obtain the desired effect. An example of the peripheral curve used by Doctor Morrison is enclosed.

Doctors Newton K. Wesley and George N. Jessen use the peripheral curve for the venting of the contact lens. "The purpose of the peripheral curve is to allow a free-flow of the pre-corneal fluid under the lens. The peripheral curve is made considerably flatter than the peripheral portion of the cornea." The radius usually recommended is 12.25 millimeter with a .4 millimeter width.

Bier and Moss influenced the fitting procedure known as the modified contour philosophy by their original work on the contour principle. The lens is designed to parallel the corneal contour with a slight clearance to provide a space for tear exchange and for rocking of the lens. The standard width usually is at least .4 millimeter, but ranges to 1.2 millimeter. The standard radius proposed by this philosophy is one millimeter flatter than the base curve. This philosophy differs from the two methods previously mentioned. An attempt is made to achieve a
MORRISON'S CONTACT LENS

Radius 7.8mm

Parabolic Transition

Radius 9mm

Blend Radius 15 mm

Blend Radius 18mm

126° Angle Blend

157° Angle
more even bearing area with the peripheral curve aiding in the support of the lens. They advocate having the entire posterior surface of the contact lens closely parallel the cornea, while the others mentioned are concerned only with the clearance of the curve and its ability to allow a good tear flow under the lens.
DISCUSSION

In the thesis three main areas were evaluated: 1) lens movement or lag, 2) fluorescein studies, and 3) subjective evaluation.

**Lens movement or lag**

By maintaining the same lens specifications as the previous lenses, changes in lens position, stability, or movement were attributed to the peripheral curve radius.

Girard says that there are two types of improper movement with blinking: 1) insufficient or no movement, and 2) excessive movements.²

Mandell evaluates the fitting characteristics by having the patient look straight ahead with the lid drawn apart by the fitter. "A well fitted lens falls one to two millimeters in a smooth motion, a loose lens falls rapidly to the limbus, and a tight lens remains in a center position."³ He considers a "tight" lens as one that resists movement by external force, and remains stationary on the cornea. A "loose" lens is considered to be one that moves freely on the cornea.⁴

The lens lag may be termed as "small" or "large, and usually requires some experience on the part of the examiner in determining this lag. According to Grosvenor:

"... in general, if the lens lags no more than one or two millimeters after a blink, the lag can be described as "small" (a relatively tight lens), and if it is more than this amount, it can be described as "large" (a relatively loose lens). Speed of lag is also important; the faster the lag, the looser the lens."⁵
Having established the requirements for good and bad lens movements, these movements, termed the lag, need to be classified.

Grosvenor classifies three types of movements:

1) Blink lag—due to lid altering the position of the lens as it moves over its surface.
2) Movement lag—due to movement of the eye from side to side.
3) Gravity lag—as the upper lid is held so as to not touch the surface of the lens, the movement or placement of the lens will be entirely due to gravity.

Only the changes in the blink lag and gravity lag of the lens movements were considered in the evaluations. Changes in movement characteristics were noted from flattening the peripheral curve.

**Fluorescein patterns**

The fluorescein patterns of each patient were checked very closely with the Burton lamp and the slit lamp. All fluorescein characteristics of the patient's previous lenses were noted before the initial dispensing. After each modification the patient wore the lenses a few days, and was then checked with the Burton lamp and slit lamp again. Any change in the fluorescein patterns which could be attributed to the changes in the new lenses were noted, and improvements in the fluorescein patterns were credited to the new lens' peripheral curve.

The value of the fluorescein pattern used to evaluate the integrity of the corneal epithelium is noted by Mandell.

"Epithelial injury may be caused by the chemical and physical changes that occur in the cornea when a contact lens is worn or by direct trauma. The fluorescein dye will collect or stain where destructive changes have occurred in the corneal epithelial tissue. A clear outline of the injured area may then be seen."
This research dealt with controlled variables, and was concerned only with the effect of the gradual flattening of the peripheral curve of the contact lens. Therefore, any problems the patient may have had due to an ill fit of his previous lenses were disregarded, and no attempt was made to correct the prescription. All dye retention patterns were noted, but only changes in the fluorescein pattern were recorded.

**Subjective Evaluation**

The third area of evaluation was the responses of the individual subjects. The patients gave impressions of the lenses; first, as compared to the previous prescription, and then, as compared to the thesis lenses, before and after each modification.

Items on the evaluation form were checked indicating the problems each experienced and whether the problems subsided as the peripheral curve was flattened.
PROCEDURE

Initial Visit

1. A pair of contact lenses was prescribed for each patient using the same design characteristics as the previous lenses except for the peripheral curve radius which was prescribed one millimeter flatter than the base curve.

2. The patient was given Form #1 to fill out (enclosed). The subjective symptoms of the previous lenses were noted.

3. The patient's previous lenses were evaluated with the Burton lamp and the slit lamp, and the following information was recorded:
   a. position of lens
   b. lag
   c. fluorescein pattern

4. Keratometer findings were taken.

5. The patient was given the prescribed thesis lenses, and was instructed to return to the clinic in two days.

Subsequent Visits

1. When the patient returned Form #2 (enclosed) was filled out.

2. The patient's lenses were then evaluated as to position, lag, and fluorescein pattern.

3. The patient was then asked to remove the lenses, keratometry readings were taken, and the peripheral curve radius was flattened by one diopter.

4. The patient then replaced the lenses and was asked to return to the clinic in one and one half days for a re-evaluation.
**HISTORY:**

- Allergies or Hay Fever?
- Sinus?
- Pinguecula or Pterygium?
- Eye injuries, diseases, infections, or operations?
- Diabetes?
- Thyroid problems?
- Other medical problems?
- Headaches? Where located? How often?
- Sensitivity to light?

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1. **How long have you worn contact lenses?**
2. **How long have you worn your present lenses?**
3. **Do your present lenses give you any problems?** (explain)
4. **How many times have you had your present lenses changed or modified?** If so, why?
5. **Date of your last contact lens check?**
6. **Have you ever injured your eyes with contact lenses?** If so, when and how?
7. **Do your present lenses get displaced in your eyes?** Which one?
8. **Do your lenses ever fall out for no particular reason?** Which one?
9. **What, if anything, is wrong with your present lenses?**
10. **Do you ever experience any**
    - Burning
    - Halo
    - "Red" eyes
    - Flare
    - Irritation
    - Itching

**ANY OTHER PROBLEMS OR ELUORATIONS OF ITEMS ABOVE, EXPLAIN ON BACK.**

<table>
<thead>
<tr>
<th>OD</th>
<th>OS</th>
<th>Lag direction</th>
<th>Lag time (sec)</th>
<th>Lens position</th>
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</thead>
<tbody>
<tr>
<td>OD</td>
<td>OS</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>

**OD**

- Pupillary size: dim
- Corneal diameter: __________
- Palpebral fissure: __________

**OS**

- Pupillary size: bright
- Corneal diameter: __________
- Palpebral fissure: __________

**POWER THICKNESS**

<table>
<thead>
<tr>
<th>OD</th>
<th>OS</th>
<th>&quot;K&quot;</th>
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| 1 2 3 4 5 | 1 2 3 4 5 |"K""K"
PRESENT SYMPTOMS:

- Burning
- Itching
- Halos
- "Red" eyes
- Flare
- Irritation
- Tearing
- Blurring
- Fogging
- Headaches
- Pain
- Any other

1. Do your lenses fall out or move around excessively?

2. Do your lenses ever become displaced on your eyes? If so, which one?

<table>
<thead>
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<th>BEFORE</th>
<th>AFTER</th>
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<tr>
<td>OD</td>
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<td>Lag sec.</td>
<td>Lag sec.</td>
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FLUORESCIN:

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<td>Lens position</td>
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<td>3</td>
<td>4</td>
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<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

SLIT LAMP EXAM

EDema 1 2 3

where? OD OS

ABRASION
PUJCTATE STAINS
STIRRING

"K" READINGS OD OS

CHANGES MADE OD OS

EVALUATIONS
EXPLANATION OF THE GRAPH

Dioptic changes were made to the peripheral curve which initially was one millimeter flatter than the base curve of the lens.

Fluorescein staining was based on changes occurring which were different from the patients' initial contact lenses. Special consideration was given to central staining.

Subjective symptoms were based on questions asked the patient on each visit.

The criteria for lens lag was based on material from Girard which stated, "no movement or excessive movement creates a poor lag" and Mandell which stated, "a good lag is one that moves one to two millimeters down in a smooth motion."
Percentage of Cases showing graph notations.

Graph Notations
- Subjective Symptoms
- Fluorescein Staining
- Optimum Lens Lag

Dioptic Changes of Peripheral Curve Radius.
CONCLUSIONS

Lens Movements

1. The lenses tended to lag very little when first dispensed.
2. As the peripheral curve was progressively flattened, the lens movements increased and in most cases an optimum range was established.
3. Additional flattening tended to cause the lens to have excessive movements.
4. The optimum range of the lag movements occurred between four and five diopters flatter than the initial peripheral curve radius.
5. The overall position of the lenses did not change, but the stability of the lens was affected by the flattening.

Fluorescein Patterns

1. Initially, all patients experienced fluorescein staining more than was noted with the previous contact lenses.
2. The number of patients experiencing this staining decreased as the peripheral curves of the lenses were flattened.
3. The optimum amount of change in the peripheral curve radius that indicated a significant reduction in dye retention was between three and six diopters flatter than the initial specifications.
Subjective Evaluations

1. Only one out of ten patients could tolerate the lenses initially. Some could not wear them at all, but most tended to find difficulty in wearing the lenses after four or five hours. One of the ten was unable to wear his lenses at any time during the thesis project.

2. As the peripheral curves were flattened the lenses were more comfortable. Beyond a certain degree of flattening it was reported by the patients that the lenses did not feel any different, but that the lenses tended to move around more.

3. Subjectively, the optimum range occurred five to six diopters flatter than the initial lens peripheral curve radius.

In evaluating the lag, fluorescein and subjective symptoms the desired range of the peripheral curve radius seems to lie between four to six diopters flatter than the initial peripheral curve radii. This would indicate that a range from approximately 1.8 millimeters to -2.2 millimeters flatter than the base curve radius would be selected as the preferred peripheral curve radius in an initial design for a contact lens prescription.
FOOTNOTES


2 Louis J. Girard, Editor, Corneal Contact Lens, C.V. Mosby Co. (St. Louis, 1964), p. 251.


4 ibid.


6 ibid.

7 Grosvenor, p. 179-180.

8 Girard, p. 251.

9 Mandell, p. 107.
BIBLIOGRAPHY

Girard, Louis J., Editor, Corneal Contact Lens, C.V. Mosby Co. (St. Louis, 1964).


