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THE APPLICATION OF BIFOCAL CONTACT LENSES TO THIRTY PRESBYOPES

BY

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Introduction

Interest in developing a corneal contact lens which would contain a plus add has been keen since contact lenses began to gain popularity in this country around 1950. The first single vision corneal contact lenses rotated so that early attempts at incorporating adds involved placing the add in the outer annulus of the lens. These lenses had very limited success because the size of the optical zone for distant vision was necessarily small and the annulus itself was necessarily quite narrow. After the development of prism ballast, truncation, and toric base curves in corneal contact lens fitting it became possible to introduce the add in a segment in the lower portion of the lens. There were many technical difficulties, however, in achieving a segment portion with a sharp clear dividing line and with unaberrated optics. Practitioners who hay attempted to fit bifocal corneal contact lenses had difficulty in obtaining lenses to satisfactory quality in these respects and, therefore, were prevented from developing proper standards of fit and adequate fitting procedure. This report deals with a study in which segment type bifocal corneal contact lenses supplied by Dr. M. D. Cooper, optometrist of Evansville, Indiana, were fitted to thirty presbyopic patients in the Indiana University Optometry Clinic according to a fitting procedure developed by Dr. Cooper and the senior author.

Procedure

The lenses developed by Dr. Cooper were used in this study because a study of several samples indicated that a sharp clear line of demarcation between the

segment and the distance portion had been achieved. not more than. 25 diopter of astigmatism was found in any of the ten samples studied. and the optics of the lenses were otherwise excellent.

Dr. Cooper also cooperated in inspecting and in modifying the lenses during the adaptation period. Subjects were chosen generally on the basis of their willingness to participate. Two were wearing bifocal corneal contact lenses (segment type) successfully, three in the process of being fitted with corneal bifocal lenses of other types. thirteen were presbyopes who had been examined in the Indiana University Optometry Clinic and who were asked if they would be interested in participating in this project. and twelve were presbyopes who had heard about the project and who asked to participate.

Twenty of the subjects received routine examinations conducted by clinic students of the Indiana University Division of Optometry or by the senior author. and ten were handled by two students as a special research assignment.

The fitting method employed was standardized for both groups of subjects and was based upon a) the nature of the lens used b) positioning the lens so that lower truncated edge rested on the lower lid with the eye in the primary position c) positioning the line dividing the distance and near portions of the lens one half millimeter above the lower margin of the pupil d) other criteria of satisfactory fit based upon experience gained in fitting single vision corneal contact lenses.

The lenses used in this study were prevented from rotating by incorporation of considerable prism ballast and by truncation of the inferior portion of the lens. In order to obtain these features it was necessary that the lenses be somewhat thicker than single vision corneal contact lenses. For example, the thickness of a plus two diopter lens (distance portion) was 50 m/m. The sharp dividing line between distance and near portions of the lens is obtained by lathing the two powers into the front surface. After the power is lathed into the front surface. the lens is polished but the sharp line of demarcation remains.

In determining a standard fitting procedure the following specifications were considered:

1. Power (distance and add).
2. Base Curve.
3. Peripheral Curve.
4. Diameter (vertical and horizontal).
5. Segment heighth.
6. Thickness.
7. Edge treatment.

The prescriptive power of the distance portion was selected in each case to correspond with the spherical equivalent determined subjectively which gave the best visual acuity. The add to be incorporated into the segment portion was determined by routine refractive procedure. The base curve of the lens was determined on the following basis:

Central corneal readings were obtained, then a series of peripheral readings (approximately 3 m/m. from the point on the cornea which is at the center of the area measured in obtaining central readings) were taken, one series superiorly, one nasally, one temporally and one inferiorly. If the inferior cornea readings averaged more than one diopter flatter than the central reading, the base curve was fitted from .25 to .50 diopter flatter than K. If the inferior readings were steeper than the central readings then the base curve was fitted steeper than K (.25 to .50 diopter). If the readings at the other three peripheral points showed market corneal flattening, the lenses were fitted flatter than K. If they showed little flattening, then the lenses were fitted on K. (With the exception noted). Quantitative findings cannot be usefully presented in this analysis because peripheral findings depend upon the area of the cornea measured and this varies from one method of taking peripheral readings to another. The relative flattening of the peripheral cornea was assessed in this study on the basis of being within normal limits, flatter than normal, or steeper than normal. If the central corneal readings showed more than 1 diopter of astigmatism, the base curve was in some instances fitted steeper than K. This was true when the peripheral cornea showed very little flattening and when the inferior cornea showed curvatures greater than the central cornea. One of the two peripheral curve radii was used for all subjects. A 12.25 m/m radius was used when the peripheral keratometer readings were relatively flat; and 11.00 m/m radius was used for the peripheral curve when the peripheral keratometer readings were relatively steep. The width of the peripheral curve was dependent upon the total diameter. A .4 m/m peripheral curve was used when the horizontal lens diameter was less than 10 m/m and a .5 m/m peripheral curve width was used when the over all horizontal diameter was greater than 10 m/m. The over all lens diameter was effected by an attempt to keep the difference between the vertical and horizontal diameter constant at 1 m/m. Factors used in determining these diameters were the vertical heighth of the palpebral fissure, the distance from the lower lid margin to the top of the pupil, corneal diameter as measured by the visible limits of the iris in the horizontal. The over all diameters fitted in the horizontal varied from 9.5 m/m to 16.6 m/m. In the vertical meridian the diameter of the lenses fitted varied from 8.5 m/m to 9.6 m/m. The most important single factor in choosing the vertical height was the measurement of the distance from the lower lid margin

to the top of the pupil. This was often used as the vertical heighth of the lens with .7 m/m to 1 m/m added for the horizontal diameter.

Using the method outlined above, the potical zone diameter was automatically determined by the specifications selected for the variables listed. The optical zone must be larger in bifocal corneal contact lenses than in single vision corneal lenses in order to permit an optical portion large enough to accommodate both the distance and near portions of the lens. This larger optical zone is offset at least in part by the factors of greater weight and by the tendency to fit the lens a little flatter in these subjects than experience would indicate for single vision contact lens wearers. Since the peripheral curev varied from only .4 tenths m/m to .5 tenths m/m the width of the optical zone in each case was roughly equivalent to the vertical diameter of the lens. The segment heighth of the lenses initially ordered was determined by the measurement from the lower lid margin to the lower edge of the pupil 1/2 m/m was added to this measurement to give the segment heighth specification. Using this technique the segment heighths varied from 3 to 5 m/m. The average vertical heighth of the lenses prescribed was 9 m/m. The average segment heighth was 4 m/m. When we consider that all the lower portion of the lens was usable optical zone while .4 m/m to .5 m/m at the upper margin of the lens contained the peripheral curve, the average segment heighth was .5 tenth m/m below the geometric center of the optical zone of the average lens. One further modification was considered in determining the segment heighth. When shallow anterior chambers were encountered, the segment was moved to a slightly higher position conversely when very deep anterior chambers were encountered (this in oly one instance) the segment heighth was moved slightly lower. Virtually all of the lenses fitted had plus power incorporated. Therefore, the center thickness was of prime consideration. The specification for center thickness was left to the laboratory except in those cases where the lids were contracted tightly against the globe (this condition was asked to make the center thickness less even at the risk of making the edge thickness too thin. The edges of all the lenses were treated in standard fashion, i.e. they were rolled and polished until they passed inspection under magnification.

Each patient was taught insertion and removal just after the lenses were ordered so that when the lenses arrived each patient was able to insert and remove them himself without help. An attempt was made to standardize wearing schedules but this broke down except in the ten subjects which were fitted by two clinicians. It was recommended that the lenses be worn for two four hour periods each day for three days when the patients were seen. Kearing schedule was then increased to two six hour periods per day for one week when the patients were seen again. Modifications were made at this time if indicated. Modification was necessary in approximately one half of the subjects and along one of three

lines a) in six subjects it was found necessary to increase the venting of one or both contact lenses. This was done by increasing the width of the peripheral curve if the superior peripheral corneal reading was flatter than average, increasing the width of the peripheral curve in the horizontal meridians if these curves were flatter than average with relation to the central curve or flattening the total peripheral curve if all of the peripheral readings were relatively flat. Using this method one modification was usually sufficient to eliminate problems resulting from poor ventilation of the central cornea. b) it was found necessary to change segment height in nine instances. Ordinarily when one segment had to be changed the other segment had to be changed in the same direction and in approximately the same amount although occasionally it was found that segment height was satisfactory in one lens and the lens in the lens in the other eye had to have its segment height changed. When change was found to be necessary it was most often to reduce the segment height. In those few instances where segment heighths were too low it was necessary to make new lenses. In those instances where segment height was too high segment height was decreased by filing the lower truncated portion of the lens rounding the junctions and re-polishing the lens along this surface. In two instances where the segment height was much too high cutting off the lower edge of the lens in this way caused the total vertical height to be too little and it was necessary to make new lenses *. In twelve instances it was found that the refraction through the contact lenses indicated a need for additional plus sphere in the distance portion. That this represented a refractive change was indicated by the fact that refraction just after the lenses were dispensed indicated no such need for plus and by the fact that acuity at distance decreased after one to three weeks wearing time and was improved by the addition of plus lens power. Because it was impossible to add power to these lenses this necessitated making new lenses. This was the greatest single problem in the successful fitting of the lenses. The cause of this increase in plus of the subjective was not satisfactorily determined although there was a tendency for corneas to flatten after lenses had been worn from two to four weeks flattening out base curves was not found with such wear.

* Since this study additional techniques have proved helpful in improving the wearability of these lenses.

We have found that occasionally the lens does not move up enough when the patient attempts to read, even though the segment is as high as they can tolerate without interference. We find we can use an emery board or swiss file and reduce the top of the lens, thus allowing the lens to be moved up without bumping the sclera.

The above method combined with a groove on the under or bottem side of the lens will sometimes be the best way of getting proper ventilation. This is done with a small round file and polished on a felt come that has been cut off on top.

Lid irritation is sometimes experienced on top and a bevel on the outside edge of the top 1/3 of the lens will help.

Criteria for success and adaptation to the lenses were established so that three categories emerged.

1. Complete success was considered to be achieved when the patient could wear the contact lenses all waking hours with at least 20/20 visual acuity at distance and at 16", when there was no discomfort assciated with wearing the lenses, when there were no tissue reactions, and when the patient reported that there were no annoying visual phenomena associated with the wearing of the lenses. Partial success was considered to have been achieved when the patients had at least 20/20 visual acuity at distance and near, when they could wear the lenses for at least eight hours without discomfort, and when there were no tissue changes associated with the wearing of the lenses. Some of the subjects in this category had mild complaints about visual phenomena such as occasional blurring. The failures were counted if the subjects did not achieve 20/20 acuity at distance and near, or if the visual phenomena associated with wearing the lenses were subjectively quite annoying. None of the subjects reported discomfort sufficient to wear nor were signs of tissue change noted which would indicate that the contact lenses were contraindicated. Based upon the above classification the following results were achieved based upon an analysis made after at least six weeks had elapsed since the contact lenses were initially fitted. Fourteen subjects were classified as having been fitted with complete success; nine with partial success; and seven were according to the classification failures. It is interesting to note that twelve of the fourteen persons fitted the complete success had been estimated to have had very high motivation by the clinician involved with the case. Only four of the nine subjects classified as having partial success were estimated to be highly motivated toward wearing bifocal corneal contact lenses. From the standpoint of goals in private practice all nine of these subjects could have been considered to have been successfully fitted providing the goal that the patient had established for himself was that of being able to wear the contact lenses for certain occasions whenever he desired. It can be generally stated that when the motivation is less the annoyance caused by visual phenomea associanted with the wearing of these lenses increases. There was no marked difference between the seven cases in the failur and fourteen demonstrating complete success. Five of the seven had indicated high motivation. Four of these five failed according to the criteria established because visual acuity was not improvable to 20/20 with the lenses when it was improvable to 20/20 with spectacle lenses. Because of this barrier in all cases was due to the necessity of using spherical equivalents rather than incorporating cylindrical prescription in the lenses. In two instances the annoyance created by the presence of the segment was sufficient to cause the patients to reject wearing the lenses for any considerable length of time

There was no significant differences in patients success between the two groups. Those fitted on an individual basis by clinicians and those ten who were fitted by two clinicians. Two subjects used in this investigation have been wearing bifocal contact lenses prescribed by the senior author at least two years hence without complaint. One of these used the original lenses and those prescribed during this investigation inter-changeably without building any differences. The second reported that the lenses prescribed during the course of this investigation were more comportable and that the change from distance vision to near vision seemed to be more easily negotiated to the newer yenses. Two of the subjects have failed to adapt to corneal bifocal contact lenses even though they had been under the care of the senior author for more than a year in each instance. One of these achieved complete success with the lenses used in this investigation. The other was classified under partial success. This perhaps because the motivation that was originally high was adversely effected by the long and tedious attempts to adjust to bifocal corneal contact lenses before the present lenses were prescribed. The subjects were particularly queried about the transition from the distance portion of the contact lenses to the near portion and were asked to compare this experience with that of spectacle bifocal lenses. In no instance was it reported that the transition from distance to near using the contact lenses was more troublesome than in spectacle lenses. In general, the experience was felt to be approximately the same with no difficulty in either although some of the patients who were highly motivated towards wearing bifocal contact lenses reported much easier transition from distance to near using the bifocal corneal lenses.

Summary and conclusions

The investigation herein reported was an attempt to assess both the quality of a specific type corneal bifocal contact lens and a standard method of fitting such lenses. As a result of the investigation it can be stated that the quality of these lenses is sufficient to permit their use in the private optometric practice and that the procedure employed is generally effective. Factors in the procedure which require refinement involved a) a more exact method for predicting final segment heighth b) the solution of the problem of latent need for additional plus in the distance portion and c) the ability to incorporate astigmatic correction in the lens. A follow up study involving ten subjects is now being conducted at Pacific University College of Optometry in which further refinement in the fitting and modification procedures will be attempted.

Pacific University
College of Optometry