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5-1992

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Abstract

In the art of rigid contact lens fitting, practitioners must be able to make judgements to obtain the desired fit and to overcome wearing problems for the contact lens patient. The new rigid gas permable (RGP) lens materials offer the practitioner opportunity to optimize contact lens design for use in fitting and patient management. Successful fitting techniques using RGP lenses demand careful patient selection, understanding of design principles, and proper material selection. The use of diagnostic fitting and flourescein examination can be powerful tools in reaching a successful fit and management evaluation for your patients. This paper/video will discuss and illustrate the effects of variations in base curve, diameter, power, center thickness, and edge profile. Through use of high resolution biomicroscopy we will demonstrate how varying these parameters will clinically alter the lens-cornea fitting relationship.

Degree Type
Thesis

Degree Name
Master of Science in Vision Science

Committee Chair
Cristina M. Schnider

Subject Categories
Optometry

THE EFFECT OF SYSTEMATIC LENS PARAMETER VARIATION ON THE FITTING CHARACTERISTICS OF RGP LENSES

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A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1992

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Abstract

In the art of rigid contact lens fitting, practitioners must be able to make judgements to obtain the desired fit and to overcome wearing problems for the contact lens patient. The new rigid gas permable (RGP) lens materials offer the practitioner opportunity to optimize contact lens design for use in fitting and patient management. Successful fitting techniques using RGP lenses demand careful patient selection, understanding of design principles, and proper material selection. The use of diagnostic fitting and flourescein examination can be powerful tools in reaching a successful fit and management evaluation for your patients. This paper/video will discuss and illustrate the effects of variations in base curve, diameter, power, center thickness, and edge profile. Through use of high resolution biomicroscopy we will demonstrate how varying these parameters will clinically alter the lens-cornea fitting relationship.

Introduction:

The word "change" is constantly heard in the ever exciting world of contact lenses. Change is for the good, it is healthy, etc. etc., but with change comes the added responsibility of learning what these changes mean, not only to you as the practitioner but also to your patient. From the days of PMMA's to the silicone/acrylates to fluorosilicon/acrylates, the lens design and fitting philosophies have changed or at least allowed us greater flexibility in who and how we are able to fit our RGP patients.

To obtain an "optimal" fit (good visual acuity, adequate movement and centration, healthy interaction between the cornea and contact lens), the practitioner must be able evaluate a RGP fit and then decide what parameter or parameters to vary when the initial trail lens does not provide the desired fit. Today, many practitioners have as an option to order "standard" lens designs providing the minimal information of base curve radius (BCR), overall diameter (OAD) and power, or to order a "custom" designed lens. With the standard lens order the lab is allowed to use a computer to generate the final lens parameters and design. This will often take care of the "normal" patient, but what if it doesn't? We, as practitioners are left with the option of "custom" designing a successful lens. In order to do this, the practitioner needs a complete understanding of what each parameter's effect is on the fit and what specific changes need to be done to optimize the lens-to-cornea fitting relationship. This paper along with the accompanying video will attempt to assist practitioners in understanding how changing a parameter(s) will affect the RGP fit. Each parameter chosen will be

discussed individually keeping in mind that varying one parameter will almost invariably affect others.

Lens Diameter

Most practitioners find a given diameter to use as their standard and will vary from this OAD to suit each patient's needs. Bennett[3] suggests 9.2 mm as a starting lens and depending on several factors he will deviate up or down from this. Although one lens diameter may be adequate for the majority of the patients, there are several factors to take into consideration: 1) palpebral aperture, 2) lid tension and 3) corneal topography or curvature.[1] Fitting philosophies, whether it is small and steep or large and flat can also determine OAD. Therefore it is a given that one diameter will not always be the optimal one for every patient.

Lid position will often determine the OAD as the upper lid has a major influence not only on straight ahead gaze but also with the blink. In a normal upper lid position, the margin of the lid will cross the limbus at the ten and two o'clock positions. The higher Dk materials of today allow a larger lenses to be fit with less concern for corneal edema. This may also aid in patient comfort if the lens is positioned under the upper lid thus eliminating the sensation of the lens awareness to the lid margin.[2] Mandell suggests the following guideline: for large palpebral apertures (>11.0 mm) try a 9.6 mm OAD, for a medium aperture (9.0-11.0 mm) try a 9.2 mm OAD, for a small aperture (<9.0 mm) try a 8.8 mm OAD lens. An interpalpebral lens is used in instances where a patient has a highly positioned

upper lid in which it is impractical to attempt to have the lens rest underneath the upper lid.

Lid tension is another variable that will influence the RGP fit and therefore the choice of OAD. It is hard to determine or measure the lid forces involved and is something in which further studies need to be done on. Even so, each practitioner should get a feeling as to whether a lid is loose or tight. Some agreement on loose lids has been reached in that larger than normal lenses are often used (0.2-0.4 mm larger).[1]

Corneal topography is one of the most studied factors, yet it is also one of the most difficult to determine in an average practice without sophisticated office equipment or extended chair time. Flatter corneas (>8.0 mm) are usually larger than the normal corneas and therefore are often times fit with a larger and flatter lens (9.5 mm). A steeper cornea (<7.5 mm) would be fit with a smaller and steeper lens (9.0 mm).[4] The way of the future may be in the computer generated mapping of the corneal topography allowing a more precise evaluation.

Increasing lens diameter will do several things to the fit and lens design. One, it will affect center thickness (CT) and edge thickness (ET), and secondly, it will affect lens movement. The center of gravity moves posteriorly with increased OAD. Minus lenses will have thinner centers and thicker edges which can decrease patient comfort and increase lens-to-lid interaction. Plus lenses are just the opposite in design and thus can create the "watermelon seed" effect, with lid forces pushing the lens out from underneath the upper lid and it moves anteriorly with a smaller

OAD. The amount of movement is affected by OAD. With larger lenses less movement is needed with each blink (good lag with the blink), and smaller lenses a "snap-back" action is needed with blink.

Again, much on how a practitioner decides on which diameter of lens to chose will depend on his/her individual fitting philosophies and individual patients. Understanding the reasons why and when to use a specific OAD will increase fitting success and reduce chair time.

Base Curve Radius

The determination of which base curve radius (BCR) requires an understanding of the lens to corneal topography relationship to produce the most successful fit. An alignment fit is the general goal in RGP fitting. A starting point in BCR choice is from the results of your keratometer readings. It must be remembered that the keratometer only measures the central 2-3 mm of the cornea, leaving a significant amount of corneal topography unmeasured. The cornea has an aspheric (elliptical) shape with the asphericity varying in different meridians.[2] Several terms are used to define this corneal asphericity. The p-value was proposed by Guillon et al with an average value of approximately 0.8.[9] Spherical corneas have a p-value of 1, while a paraboloidal shaped cornea has a p-value of 0.[9] A second term used used to define corneal eccentricity is the e-value. The average e-value for the human cornea is 0.45. As corneal flattening increases so does the e-value from zero (a spherical cornea) to one.

The cornea-to-lens fitting relationship and desired BCR can be evaluated several ways: 1) observed movement, and 2) fluorescein

pattern evaluation. With the alignment fitting philosophy, or on-K fit, a certain amount of apical clearance is needed for an optimal fit. Townsley suggested a desired tear layer thickness (TLT) between the central cornea and lens of 0.025 mm while Guillon suggested a TLT of 0.02 mm is adequate.[9] As each patient's corneal topography varies so will the decision on whether the initial BCR chosen needs to be made steeper or flatter. Once the fluorescein pattern is examined the practitioner can then change the BCR with the knowledge that a change of 0.1 mm(0.50D) in BCR causes a TLT change of about 0.015 mm.[2] Without an instrument to measure the corneal eccentricity (eg. photokeratometer, autokeratometer), the evaluation of the fluorescein pattern will weigh heavily in the final decision as to what BCR and peripheral/intermediate radii/widths will be ordered. The movement and centering can be affected with steepening and flattening of the BCR as the center of gravity moves posteriorly and anteriorly with the respective changes.[1]

Peripheral Curves

The peripheral and intermediate curves have several functions and the choice of their width and radii will determine whether or not they fulfill their purpose. The intermediate curve (IC) will bear a major portion of the lid forces exerted upon the cornea by the lens.[10] The peripheral curves (PC's) serve several functions. One, influencing contact lens movement/centration and secondly, aiding in the interchange (pumping) of the tears between the lens and cornea. Widening or flattening the PC's will aid in movement of the lens with the blink and increase edge clearance, allowing increased tear

exchange. Several values are used to define edge clearance (EC), axial edge lift (AEL) and radial edge lift (REL). AEL is defined as the measurement of the distance from the extension of the base curve up to the edge of the lens measured parallel to the axis of the lens. REL, also known as linear clearance, is defined as the distance from the base curve surface extending to the lens edge from the base curve radius. Edge clearance is determined by the lens parameters which is independent of the individual eye's corneal topography and peripheral rate of flattening.

As the peripheral curves determine the amount of EC, most practitioners agree that an EC of approximately 0.08 mm is adequate.[2] When other lens parameters are held constant, widening and flattening the PC will increase EC. With daily wear RGP's the edge clearance can be less than with PMMA's, but with extended wear rigid lenses it has been shown that in order to avoid lens binding with overnight wear greater edge clearance is needed.[11] This allows more interaction between the lid and the lens and thus greater tear flow exchange.

One attempt to match corneal flattening by practitioners has been to design a lens with an aspheric periphery and a spherical center of 3-4 mm.[2] This allows for superior optics while attempting to follow the corneal topography to aid in comfort and fit. This design is similar to the heavily blended lens which simulates the aspheric design. Aspheric lenses were designed to address several concerns, ranging from corneal topography, comfort, edge design and clearance to minimizing bearing zones on the cornea. Aspheric lenses must be fit steeper than spheric lenses to maintain optimal clearance between

the lens and cornea. This means that the e-values of 0.5 to 0.6 are used in order to compensate for the fact that aspheric lenses flatten faster than the corneal periphery.[2]

Optic Zone Diameter

In conjunction with such parameters as base curve radius and overall diameter, the optic zone diameter (OZD) is often specified in a rigid gas permeable lens order for a "best fit". Varying the OZD can accomplish several changes in the desired fit, such as decreasing flare from the secondary curves or flattening the lens. Like other important parameters shown by Theodoroff and Lowther, smaller OZD's (7.4 mm) had significantly more vertical and horizontal displacement than two larger OZD's (7.9 & 8.4 mm). This can help the practitioner when the optimal fit can be achieved by only changing a single parameter in order to obtain a more centered lens. It was also stated that a combination of factors, mainly corneal shape and lid attributes may have the greatest influence on positioning and centering of the lens.[12]

The exact size of the OZD depends on several parameters: lid positioning, palpebral aperture size, pupil diameter in dim lights, and "K" readings to name a few. Lenses with too small a OZD can induce unwanted flare and image-ghosting. In order to avoid flare, the OZD should be 0.5 mm larger than the pupil diameter in dim room lighting. Too large of an OZD, however, can create seal-off, interrupting tear exchange and disrupting lens movement.[4] This seal-off is do to the junction between the base curve and secondary curve being further out on the periphery of the cornea, leading not

only to discomfort, but also to increased peripheral corneal desiccation.

Two other concepts that must be considered when determining OZD are sagittal depth and corneal topography. If the BCR is kept constant the sagittal depth will increase as the OZD increases. Secondly, as the cornea flattens into the periphery, a greater flattening will cause an increase in the central tear layer thickness. So, in order to maintain a constant TLT the BC radii must be changed appropriately. For example, a 0.5 mm decrease in the OZD would require a 0.03 mm shortening in the base curve radius.[2] The OZD is just one of many parameters that the practitioner needs to consider when choosing to custom fit a rigid gas permeable lens.

Lens Thickness

Several goals are looked at where center thickness (CT) is concerned. The first goal is a realistic maximum CT to avoid unwanted lens flexure and secondly a lens thin enough to allow sufficient oxygen permeability and avoid corneal edema.[4] Bennett states that deciding on a center thickness should not be made on the basis of oxygen permeability but on such factors as vision, lens stability, and positioning. His reasoning for this is shown in the following example that by increasing CT by 0.04 mm the mass of the lens increases by 24%, while oxygen permeability is affected by less than 1%.[3] Minimum center thickness for minus lenses is approximately 0.13-0.15 mm, while plus lenses should have a center thickness of less than 0.45 mm. Bennett suggests two rules of thumb when determining CT:

1) increase center thickness by 0.02 mm for lens materials with Dk values greater than 40.

2) increase center thickness an additional 0.02 mm for each diopter of corneal astigmatism.[5]

In general, materials with higher Dk will flex more than lower Dk materials and therefore usually require a greater CT.

Center thickness is an often overlooked parameter that left for the manufacturer to determine. Although, it is affected by many parameters, but lens power and overall diameter have the greatest influence.[3] Plus lenses will have a greater CT and the center of gravity will move anteriorly. Just the opposite occurs with minus lenses as the center thickness decreases, the edge thickness increases and the center of gravity moves more posteriorly. Increasing the overall diameter will also move the center of gravity posteriorly.[1]

Edge thickness must also be considered when designing a custom fit RGP lens. Edge thickness is influenced by parameters such as power or overall lens diameter. The optimal lens thickness is usually between 0.08 mm and 0.12 mm.[4] This should allow sufficient tear exchange with minimal discomfort and proper lens to-cornea along with lid interaction. Edge clearance has been discussed in the peripheral curve section and will not be repeated here. The design of the edge is also of considerable importance. The interaction between the lid and lens is critical to patient comfort and requires careful inspection by the practitioner. Higher Dk material is softer in general so it is more susceptible to chipping and breakage.

Lenticulation of the edge is often times used to improve lens performance. A plus lenticular is used with powers of -5.00D or

greater in order to decrease edge thickness and minimize associated problems such as lens awareness, inferior lens positioning and desiccation due to increased lens-to-lid-to-cornea interaction. A minus lenticular is used to enhance lid interaction with the lens to aid in positioning and centering of the lens. Two examples of it's use are with plus lenses and with low minus lenses (less than -1.50D).[2] The concern with low minus lenses stems partially from lens mass and maintaining adequate edge thickness. The minus lenticular allows increased edge thickness providing for lid attachment without adding to the center thickness thus avoiding excessive mass which can cause the lens to drop inferior.[8]

Summary

While each of the above parameters were discussed as individually as possible, it is obvious that each is intrinsically related. With the assistance of the video and this paper it is hoped that a better understanding of the individual parameters will aid in the "art" of fitting a rigid gas permeable lens. Whether custom fitting or using a standard manufactured lens, the contact lens practitioner must be able to evaluate the fit and make changes accordingly. Knowing which variable(s) to change and how it will affect the fit is the attempted goal in this paper and video tape.

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