Pacific University

CommonKnowledge

College of Optometry | Theses, Dissertations and Capstone Projects

2-8-1980

Motion picture analysis of hard contact lens fitting

John W. Randall
Pacific University

Timothy J. Smith
Pacific University

Motion picture analysis of hard contact lens fitting

Abstract

Various hard contact lens fitting techniques were filmed in color and analyzed. The topics studied were the following: l. changes in Base Curve (BC) with all other parameters held constant, 2. changes in Overall Diameter (OAD) with all other parameters held constant, 3. changes in Optic Zone Diameter (OZD) with all other parameters held constant, 4. effect on tear fluid exchange when the Peripheral Curve Radius (PCR) is widened, 5. the observation of the fluorescein pattern on a highly toric cornea. This film is to be used as an instructional aid for second ·' year contact lens students at Pacific University College of Optometry.

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

James Peterson

Subject Categories

Optometry

Theses
Opt.
Randall

MOTION PICTURE ANALYSIS OF HARD CONTACT LENS FITTING

A Thesis

Presented to the

Graduate Faculty of the

College of Optometry

Pacific University

by

John W. Randall and Timothy J. Smith

Approved by:

James E. Peterson, O.D. — Feb. 8, 1980
Date

Lynn G. Coon, O.D.

MOTION PICTURE ANALYSIS OF HARD CONTACT LENS FITTING

A Thesis

Presented to the

Graduate Faculty of the

College of Optometry

Pacific University

In Partial Fulfillment

of the Requirements for the Degree of

Doctor of Optometry

by

John W. Randall and Timothy J. Smith

Forest Grove, OR 1980

Table of Contents

Acknowledgements

We would like to thank our advisors, Dr. James E. Peterson and Dr. Lynn J. Coon for their valuable guidance and many helpful suggestions in helping us to complete this project.

Abstract

Various hard contact lens fitting techniques were filmed in color and analyzed. The topics studied were the following: 1. changes in Base Curve (BC) with all other parameters held constant, 2. changes in Overall Diameter (OAD) with all other parameters held constant, 3. changes in Optic Zone Diameter (OZD) with all other parameters held constant, 4. effect on tear fluid exchange when the Peripheral Curve Radius (PCR) is widened, 5. the observation of the fluorescein pattern on a highly toric cornea.

This film is to be used as an instructional aid for second year contact lens students at Pacific University College of Optometry.

Introduction

Still photography is a practical and precise method of data recording. The human eye has been the subject of much photographic research [1,2,3]. Research concerning contact lenses especially has benefited from photography. Photographs are also used extensively in the education of eye care professionals [4,5]. Cinematography, however has not been widely used in the ophthalmic field. Motion pictures have several obvious benefits. This paper has two purposes: 1. To develop a means of documentation through cinematography and 2. To use motion pictures to study contact lenses.

In fitting contact lenses, an accurate analysis of the fluorescein pattern is very useful in evaluating the fit of a particular lens. Many studies have been done which analyze the fluorescein pattern using still photography. Koetting has demonstrated photographically the effects of toric curves, flat peripheral curves, and lenticular designs on various types of corneas [6]. Mandell also presents an analysis of various types of steep and flat fits on both spherical and toric corneas [7].

Although these types of still photography are very beneficial in the understanding of the contact lens-cornea relationship, they do not demonstrate the dynamic interactions present in contact lens fitting. They fail to show, for example, the dynamic relationship of the lids to the lens during a blink, or the manner in which the tear layer changes underneath the lens.

A few practitioners have attempted to take motion pictures of the contact lens fluorescein pattern. Junge used a super 8mm camera with a 90mm tele-lens and an extension ring [8]. Three 125 watt ultra-violet lamps were required to provide the necessary illumination.

Harris, et al used motion pictures to analyze the rotation of spin-cast Bausch and Lomb hydrogel lenses on the eye [9]. Lens rotation was recorded with high speed (24 frames per second) motion picture film (Ektachrome, ASA 160). A Nikon super 8mm camera was used, in conjunction with a 3X macrolens. To alleviate focusing problems at such a close distance, the subjects were firmly placed in a chin rest/head rest apparatus. Each of twelve lenses was filmed on all six eyes two minutes and 30 minutes after insertion. To analyze lens rotation, the film was projected at a distance of six feet using a stop-action Bolex super 8mm projector. The film was allowed to run for a period of ten blinks, and the change in position of any of the reference marks was noted. The accuracy of this method was verified by repeated measurements of the amount of rotating of one lens. Some of the lenses did rotate, but there was no way found to predict this in advance.

Anterior segment cinematography which is not related to contact lenses has also suggested important techniques. Wells and Edgerton studied the blood flow in the conjunctival vessels by means of a 16mm reflex Pathe cinematography camera, mounted on a Leitz focusing ophthalmic head stand [10]. A xenon strobe lamp housed in a large Pyrex test tube was mounted at 45 degrees to the camera angle on the stand and synchronized by a contactor attached to the film advancing mechanism. A 40mm macrolens was adapted to a 5.25 inch extension tube in place of the conventional lens, providing a magnification of 3.75 times. Filming rates varied from eight to 32 frames per second. Film was Kodak TV recording film 7374 ASA 80. Light for focusing consisted of an American Optical microscope illuminator mounted next to the strobe film.

Most authors favor the use of Kodak high-speed Ektachrome film for color anterior segment photography [11]. Bailey, Goodlaw, Rengstorff and Krause, and Ciuffreda reported their preference for high-speed Ektachrome (ASA 160) in macrophotography and slit lamp photography [12,13,14,15]. Skolnik and Baumann used ASA 125 tungsten color balance film but developed at an ASA rating of 400 [16]. This enables lower light levels to be used, a definite advantage in filming contact lens fluorescein patterns. The method would also be of use in high magnification and non-flash slit lamp photographic applications.

In order to take motion pictures of a fluorescein pattern it is beneficial to filter out the visible part of the spectrum and transmit the ultra-violet light. This is done by using a Roscoe 37 blue filter in a special mount that slips over the electronic light source [17]. To give the desired contrast between the fluorescein and the rest of the eye a K 2 yellow filter is attached to the front of the camera lens. This combination of filters, selected after numerous tests by Bailey produces good fluorescein pictures [18].

The film produced in our project demonstrates some of the basic principles involved in successful contact lens fitting.

The film is to be used as an instructional aid for second year optometry students as they begin their contact lens courses at Pacific University College of Optometry.

Methods

A. Equipment-The following equipment was used:

1. Camera-Sankyo E5-66XL super 8mm
2. Illumination-Room illumination of five foot-candles combined with two Burton lamps positioned six inches from the eye at the nasal and temporal sides. In addition, a 75 watt black lamp positioned 12 inches above the eye was used.
3. Contact lens visibility-Fluorescein provided the best means of making the contact lens visible.
4. Film-Kodak Type G Ektachrome 160 color movie film for indoor or outdoor use without filters was used.
5. Distance-We filmed at a distance of five cm from the front of the movie camera lens to the cornea.
6. Film Speed-36 frames per second proved to be successful in filming a normal blink.

B. Subjects-The majority of the filming was done on one subject, whose 'K's were 47.50 D at 90 and 47.00 D at 180. The second subjects 'K's were 42.00 D at 180 and 44.25 D at 90.

The term 'K' used below refers to the flattest corneal meridian as measured with an ophthalmometer [19].

The abbreviations are as follows; Base Curve-BC, Overall Diameter-OAD, Optic Zone Diameter-OZD, Peripheral Curve Radius-PCR, Peripheral Curve Width-PCW, and Center Thickness-CT.

On the first subject we filmed the following:

1. The changes observed as the BC was changed from 2.00 D steeper than 'K to 2.00 D flatter than 'K'. All other parameters were held constant.
2. The changes observed as the OAD was changed from 9.3mm to 8.0mm. OZD remained constant at 7.5mm and PCW varied accordingly. All other parameters were held constant.
3. The changes observed as the OZD was changed from 7.9mm to 7.1mm. OAD was constant at 8.8mm and the PCW varied accordingly. All other variables were held constant.
4. The changes observed in the fluorescein pattern when the PCR is increased by 2.0mm.

On our other subject we demonstrated the fluorescein pattern observed on an eye with 2.25 D of with the rule corneal toricity. This segment was used to demonstrate a situation in which the practitioner might consider the use of a toric contact lens.

C. Results-The results of our project are best seen in the film itself. Presented below is the sound commentary explaining the film.

1. The effects of changing BC with OAD, OZD, PCR, PCW, CT, and blend remaining constant.

Lens 1. BC: 2.00 D steeper than 'K'
OAD:8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

In this lens we see a bright central pooling of fluorescein. A bubble is seen in the very center of the lens. Notice that the lens does not move on blinking. This is a poor fit because the lens is too steep, creating limited tear exchange, which frequently leads to corneal edema.

Lens 2. BC: 1.50 D steeper than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Here we notice that a bubble is still present in the center of the lens, indicative of a steep fit. The lens moves a bit more than the previous one. However, this movement is still not enough to be considered acceptable.

Lens 3. BC: 1.00 D steeper than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Although we do not see a bubble here, notice the bright central pooling and the very limited movement. This lens is still too steep to be considered an acceptable fit.

Lens 4. BC: 0.50 D steeper than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.50mm
CT: 0.17mm
Blend: A

Notice the movement of this lens compared to the others demonstrated thus far. The lens moves up approximately 2mm on the blink, then quickly moves down to position itself on the center of the cornea. This demonstrates a reasonably good fit.

Lens 5. BC: 0.25 D steeper than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

This fit is similar to that of the 0.50 D steeper than 'K' fit. The lens moves up about 2mm on the blink, then centers well on the cornea. However, note that this movement is a bit faster than the 0.50 D steeper than 'K' lens which makes this fit ideal in its tear pumping mechanism.

Lens 6. BC: on'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

This fit is fairly acceptable. Notice that the lens does not center as well as the last two lenses. It has a tendency to sink somewhat, which suggests that it might be a bit too flat.

Lens 7. BC: 0.50 D flatter than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Observe how this lens centers momentarily then sinks downward. This is unacceptable because the movement is too excessive.

Lens 8. BC: 1.00 D flatter than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

In this fit the lens does not center at all and slides down and temporally quickly after the blink. This type of excessive movement could cause a mild epithelial abrasion which would stain with fluorescein.

Lens 9. BC: 1.50 D flatter than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Observe here the dark bearing area in the center of the lens demonstrating the apical touch characteristic of a flat fit. This illustrates a concept of Peterson which is that when a lens is too flat it will either rise or sink [20]. Notice that after a blink this lens gets caught up under the upper lid momentarily and then sinks quickly downward on the cornea.

Lens 10. BC: 2.00 D flatter than 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

This lens further demonstrates the characteristics of a flat contact lens. Again, notice the apical touch area and the tendency for the lens to get caught up underneath the upper lid and than sink down and temporal on the cornea.

2. The effects of changing OAD with the BC, OZD, PCR, CT, and blend all remaining constant.

Lens 1.
OAD: 9.3mm
BC: 0.25 D steeper than 'K'
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.8mm
CT: 0.17mm
Blend: A

This lens has the same BC that gave the best fit in the previous series. But notice that the large OAD of this lens has limited its movement to a great extent because of the increase in sagittal value. The greater mass of this large lens also makes the lens position lower on the cornea. We would like to see more movement here and better centering.

Lens 2.
OAD: 8.8mm
BC: 0.25 D steeper than 'K'
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

As the OAD is decreased to 8.8mm we see that the lens movement increases on each blink. This is an acceptable fit.

Lens 3. OAD: 8.5mm
BC: 0.25 D steeper than 'K'
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.4mm
CT: 0.17mm
Blend: A

A further decrease in OAD shows a slightly faster lens lag on each blink, which is still considered acceptable. The decrease in OAD has decreased lens mass and caused better centering.

Lens 4. OAD: 8.1mm
BC: 0.25 D steeper than 'K'
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.2mm
CT: 0.17mm
Blend: A

A lens can be made to adhere less to the cornea by decreasing the OAD. Notice that the lens lag has increased in amount and speed, yet still demonstrates an acceptable fit.

3. The effect of changing the OZD, with BC, OAD, PCR, CT, and Blend held constant.

Lens 1. OAD: 8.8mm
BC: 0.25 D steeper than 'K'
OZD: 7.9mm
PCR: 8.1mm
PCW: 0.4mm
CT: 0.17mm
Blend: A

This lens has a BC/cornea relationship that is normally considered a good fit, but note that the large OZD in this lens causes a considerable adherence to the cornea and very limited lens movement.

Lens 2. OAD: 8.8mm
BC: 0.25 D steeper than 'K'
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Decreasing the OZD decreases the vaulting effect, which decreases lens adherence, and provides the ideal amount of lens movement and a very acceptable fit.

Lens 3. OAD: 8.8mm
BC: 0.25 D steeper than 'K'
OZD: 7.1mm
PCR: 8.1mm
PCW: 0.7mm
CT: 0.17mm
Blend: A

Here we decrease the amount of sag even further, demonstrating even more lens movement. This lens still illustrates a reasonably good fit.

4. The effect of flattening the PCR by 2.0mm.

OAD: 8.8mm
BC: 0.50 D steeper than 'K'
OZD: 7.5mm
PCR: 10.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

Notice that a bright band of fluorescein is distributed around the outer border of this lens, where there was previously a dark bearing area. Such a modification causes a better tear exchange.

5. Fluorescein Pattern of a Spherical BC on a toric Cornea.

BC: 0.25 D steeper than flattest 'K'
OAD: 8.8mm
OZD: 7.5mm
PCR: 8.1mm
PCW: 0.5mm
CT: 0.17mm
Blend: A

When the change in 'K's is 2.50 D or more, the practitioner should begin to consider the use of a toric BC in order to achieve a satisfactory lens/cornea fitting relationship. Observe the following fit on a cornea with 2.25 D of with the rule toricity. Since the vertical corneal meridian is steeper, a space exists between the lens and cornea at the superior and inferior periphery. This space will fill with tear fluid, as shown by the bright green vertical band [20].

Discussion

This film demonstrates the following principles of contact lens fitting according to Mandell [21].

The adherence of a contact lens to the cornea is increased by:

1. Decreasing the BC.
2. Increasing the OAD.
3. Increasing the OZD.
4. Decreasing the PCR.

The adherence of a contact lens to the cornea is decreased by:

1. Flattening the BC.
2. Decreasing the OAD.
3. Decreasing the OZD
4. Increasing the PCR.

Girard's ideas related to vaulting effect have also been demonstrated in the film [22].

1. If two lenses of the same radius of curvature but of differing diameters are compared, the larger lens has a greater vaulting (sagittal value) than does the smaller lens, thus the larger lens has a stronger adhering force to the cornea.

2. A minor increase in the diameter of the optical zone creates the same increased vaulting effect as does a major

change in steepening the radius of curvature of the lens.

Other important principles essential in successful contact lens fitting has been demonstrated by this film (these developed by Dr. James E. Peterson*)[23,24]. (See Graph I, page 22.)

When a lens is too steep, a bubble is seen under the lens. To obtain an acceptable fit, the practitioner can do one of the following things:

1. Keep the same OAD, but use a flatter BC.
2. Use a smaller OAD and the same BC.
3. A combination of the first two changes.

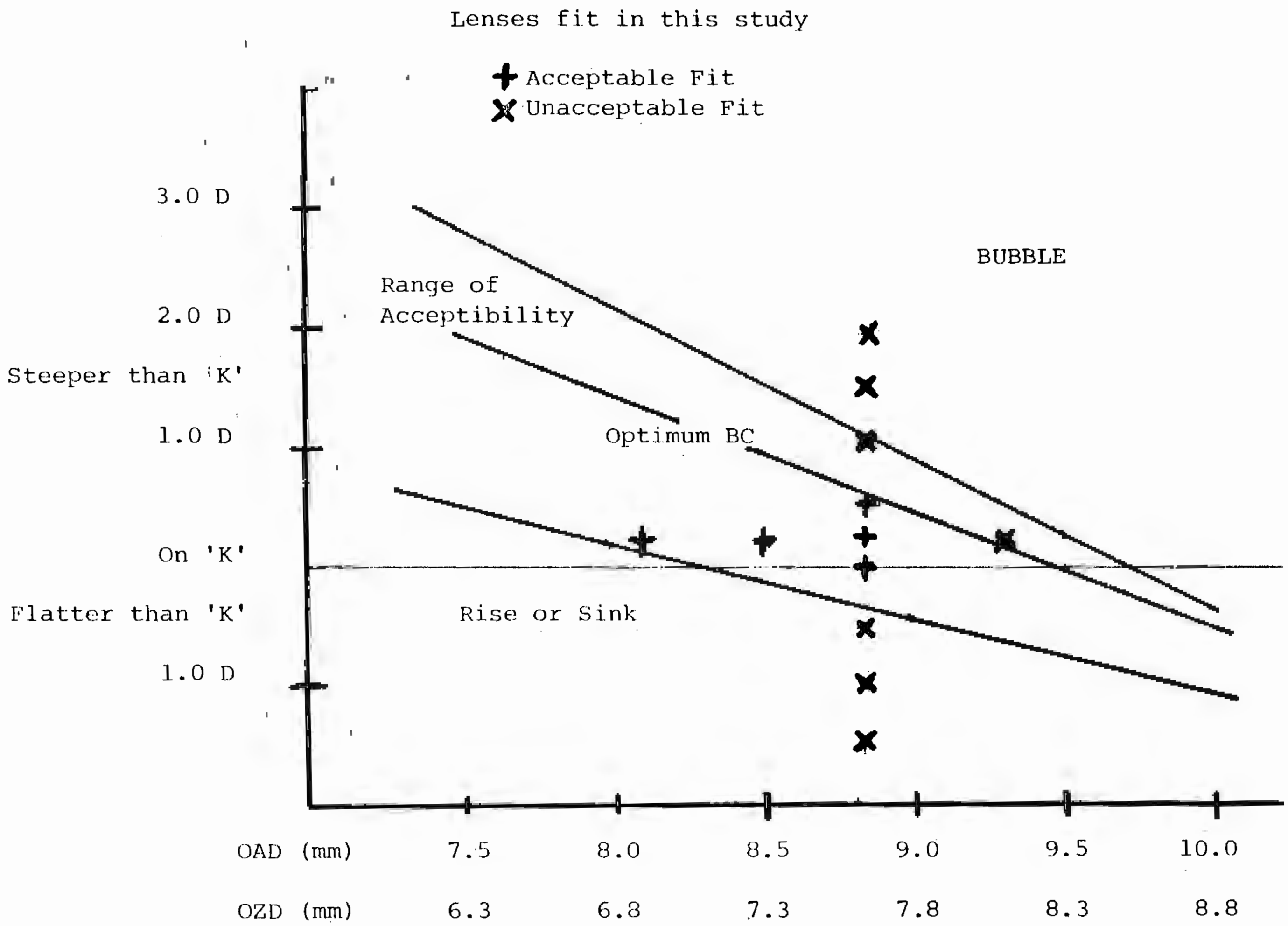
When a lens is too flat, the lens either rises or sinks. To obtain an acceptable fit, the practitioner can do one of the following:

1. Keep the same OAD, but use a steeper BC.
2. Use a slightly larger OAD and the same BC.
3. A combination of the first two changes.

As the OAD becomes smaller, the chance of obtaining a successful contact lens fit increases because the number of base curves that can be utilized to produce a good fit increases. This was observed in the film in the section showing the effects of changing the OAD of the lens with all of the other parameters

*Dr. James E. Peterson-personal communication

Graph I Range of Acceptibility



remaining constant. With each decrease in OAD, the lenses become more acceptable.

Notice that on the graph that with smaller lenses, (example 8.0mm OAD) the practitioner can select a lens 0.50 D steeper or flatter from the Optimal Base Curve Line and still be well within the range of acceptability.

For larger lenses,(example 9.2mm OAD) when the practitioner selects a lens 0.50 D steeper or flatter from the Optimum Base Curve Line the lens begins to border on the range of unacceptability.

In the course of our project we discovered a number of factors which might be helpful to those attempting to make contact lens films in the future. These factors were:

1. Minus lenses worked much better than plus lenses in allowing the edge of the contact lens to be visible on the film.

2. Avoid the use of excess fluorescein. There is a strong temptation to add more and more fluorescein to the eye in an effort to keep the lens visible throughout the filming procedure. When excessive amounts of fluorescein are used, the amount of fluorescence decreases considerably[25]. This is due to the non-disociation of the sodium fluorescein salt. The fluorescein is fluorescent only in anion form, and when the concentration

is too great, the salt cannot disociate into its anionic component. When we instilled too much fluorescein in the eye, we simply added a few drops of Adapettes or Blinx and this gave a brilliant fluorescence.

3. Any slight movement by the patient can cause an entire filming sequence to be out of focus and unuseable. Therefore, we strongly suggest the use of a chin rest in this type of motion picture photography.

Bibliography

1. Mann WA: History of Photography of the Eye, Surv. of Ophth., 15(3) p179-189, 1970

2. Minatoya HK: A Survey in Macrophotography of the Eye, Surv. of Ophth., 17(2) p100-105, 1972

3. Ciuffreda KJ and Gunter R: A Review of Anterior Segment Photography, Am. J. Opt. & Phys. Optics, 51(7) p465-469, 1974

4. Ciuffreda KJ and Gunter R: Photography at the Massachusetts College of Optometry:An Integral Part of a Total Eye Care Delivery System, New Eng. J. Opt., 24(4) p118-121, 1973

5. Sloan A and Speakman JS: Eye Photography as an Aid to Teaching, Canad. J. Opthh., 7(4) p462-465, 1972

6. Koetting RA: Ten Second Fluorescein Pattern Photgraphy, Am. J. Opt. & Arch. of Am. Acad. Of Opt., 40(11) p684-693, 1963

7. Mandell RB: Contact Lens Practice, Springfield, Illinois, Charles C. Thomas, 1974, p192-193

8. Junge J: Photography and Cinematography of the Fluorescein Pattern, Cont. Lens, 4(6) p10, 1974

9. Harris MG, Rich J, and Tandrow T: Rotation of spin-Cast Hydrogel lenses, Am. J. Opt. & Phys. Optics, 52(1) p22-26, 1975

10. Wells R and Edgerton H: Blood Flow in the Microcirculation of the Conjunctival Vessels of Man, Angiology, 18 p699-704, 1967

11. Puckett FE and Nelson SJ: Anterior Segment Photography-An Evaluation of the Various Techniques and Films, Pacific Univ. College of Opt. Senior Thesis, Spr 1978

12. Bailey NJ: Photography of the Anterior Segment of the Eye, Opt. Weekly, 56(21) p31-38, 1965

13. Goodlaw EI: Photographic Monitoring of Pathology of the Anterior Segment of the Eye, Am. J. Opt., 47 p114-123, 1970

14. Rengstorff RH and Krause CC, Jr: Guide for Slit Lamp Photography of the Eye, J. Am. Opt. Assn., 42(13) p1250-1255, 1971

15. Ciuffreda KJ: Understanding Fluorescein Contact Lens Photography: Equipment and Technique, J. Am. Opt. Assn., 46(7) p706-713, 1975

16. Skolnik A and Baumann R: Slit Lamp Eye Photography, Oregon Optometrist 39(2) p8-10, 1972

17. Dine LA: Contact Lens Photography, Am. J. Opt. & Arch. of Am. Acad. of Opt., 39(10) p548-551, 1962

18. Bailey NJ: Blacklight Photography of the Eye, Contacto, 5(3) p91-96, 1961

19. Girard LJ, ed: Corneal Contact Lenses, St. Louis, C. V. Mosby Co., 1970, p117

20. Mandell RB: op. cit., p197

21. Mandell RB: op. cit., p126

22. Girard LJ, ed.: op. cit., p120

23. Freed RJ and Sonnenberg WA: The Feasibility of Fitting a 6.0mm Hard Contact Lens, Illinois College of Optometry Thesis, Spr. 1974

24. Kotlicky M and Uhlir B: The Feasibility of Fitting and Performance of Hard Contact Lenses with a 5.0mm Overall Diameter, Illinois College of Optometry Thesis, Spr. 1975

25. Guilbault GG, ed.: Fluorescence: Theory, Instrumentation, and Practice, New York, NY, Marcel Dekker, Inc., 1967, p37-41

HUMAN SUBJECT RELEASE FORM

1. Institution
   A. Title of Project: Motion Picture Analysis of Hard Contact Lens Fitting
   B. Principal Investigators: John W. Randall and Timothy J. Smith
   C. Advisors: Dr. James E. Peterson and Dr. Lynn J. Coon
   D. Location: Pacific University College of Optometry
   Forest Grove, OR 97116
   E. Date: 1980

2. Description of Project
   In this project we will analyze various types of contact lens fits through the use of color motion pictures. The subject will place contact lenses of differet parameters on his cornea, and we will film the type of fit each lens provides. A sound track will be used to verbally analyze each lens filmed.

3. Description of Risks
   The subject may experience slight eye irritation from the contact lens solution used. There is also the possibility of corneal epithelial abrasion caused by improper lens insertion and removal.

4. Description of Benefits
   This film analysis of contact lens fits will be used as an instructional aid for second year optometry students as they begin their contact lens courses at Pacific University College of Optometry.

5. Compensation and Medical Care
   If you are injured in this experiment it is possible that you will not receive compensation or medical care from Pacific University, the experimenters, or any organization associated with the project. All reasonable care will be used to prevent injury however.

6. Alternatives Advantageous to Subjects
   Not applicable.

7. Offer to Answer any Inquiries
   The experimenters will be happy to answer any questions that you may have at any time during the course of this study.

8. <u>Freedom to Withdraw</u>
You are free to withdraw your consent and to discontinue participation in this project or activity at any time without prejudice to you.

I have read and understand the above. I am 18 years of age or over.

Signed________________________________ Date__________________________