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Eyesys vs. Mastervue RGP fitting study

Cynthia M. Bidegary
Pacific University

John P. Huard
Pacific University

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Methods: This study will assess the fitting performance, both subjectively and objectively, of two Placido based topography systems: Humphrey MasterVue and EyeSys Corneal Analysis System. Twenty four subjects were fit and dispensed a pair of lenses: one eye's lens generated by each computer. Lenses were rated by both the examiners and the patients using standard rating scales at the time of the dispensing visit.

Results: Overall the Master Vue lenses were preferred by 57% of the subjects, the EyeSys 19%, and 24% had no preference. Objectively we assessed that the MasterVue lenses physiologically out performed the EyeSys lenses a majority of the time.

Conclusions: Generally, the MasterVue software did a better job than the EyeSys program of matching base curve and overall diameter dimensions with the measured cornea. However, there is significant room for improvement in both systems to become clinically useful.

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EYESYS VS. MASTERVUE
RGP FITTING STUDY

By

Cynthia M. Bidegary

John P. Huard

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Adviser:
Christina Schnider

Signature Page

Cynthia M. Bidegary

John P. Huard

Christina M. Schnider, O.D.

Biography

Cynthia Bidegary will graduate with a degree in optometry from Pacific University College of Optometry in May of 1995. In 1992 she graduated from Pacific University with a Bachelor of Science degree, majoring in vision science. Other schools attended include the University of Washington and Valencia Community College. Future plans include obtaining and completing an Indian Health Service hospital-based residency. Upon completion of residency an associate/partnership co-management position will be pursued in the Pacific Northwest.

John P. Huard graduated with honors from Michigan State University in 1991 earning a bachelor of science with a major in physical science. While at MSU he worked full time as an optician at a local optometric office. He will be graduating from Pacific University College of Optometry in May of 1995 with his OD degree. Upon graduation he hopes to enter private practice on the west coast (or possibly the east coast) in a location that will provide an adequate environment to support his surfing obsession.

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Introduction

As the early scientists struggled with understanding and correcting refractive errors of the human eye over five centuries ago, they devised methods of assessing corneal curvature. Often the initial goal was to observe "distortions" which we now recognize as astigmatism. By 1619, however, Scheiner was comparing the size of reflected images of marbles of known diameter held close to the eye to those images formed by the patient's cornea. Eventually, as the technology advanced, these vision scientists developed a method of quantifying the actual radii of curvature in two perpendicular meridians with the invention of the ophthalmometer by Ramsden in the year 1796.[1] It was an obvious marriage to use this technology in the fitting of contact lenses. This was first done with a Javal ophthalmometer by the French physician, Kalt, in 1888. [2]

From 1888 until the present, the keratometer (ophthalmometer) has served as the primary instrumentation utilized in the measurement of corneal curvature for the fitting of both soft and rigid contact lenses. In the case of rigid lenses, it was clear to some practitioners that by only measuring the central 3mm of the cornea with a keratometer (referred to as the corneal cap), they were getting an incomplete picture of the overall cornea and were less able to predict success of a given lens. In fact, most had discovered that the cornea had a very complex shape. [3,4] In the late 1950's using small-mire keratometer studies, Mandell concluded that, "...when accurately measured, no cornea had a true cap, and each cornea was as unique as a fingerprint."[5] Knowing how important the peripheral cornea was in the dynamics of a rigid lens fitting, clinicians devised methods to assess the peripheral aspects of the cornea using existing technology: 1) Placido disc 2) Photokeratoscopy 3) Multiple off-axis keratometry readings, to name just three. These all gave some level of understanding of the peripheral cornea, but were either too time-consuming, cumbersome, inaccurate, or were difficult to reproduce with any level of consistency. The end result of these shortcomings was that these methods have not been widely utilized by practitioners. Currently, most practitioners simply use a keratometer to measure what they believe to be the corneal cap, then follow existing or self devised fitting philosophies that either ignore or guess at peripheral corneal dimensions.

Although multiple rigid gas permeable (RGP) fitting philosophies exist, two prominent yet quite different methods will be discussed.[6] The first is known as the Korb philosophy of fitting. An optimal Korb fit has several characteristics:

1) A lens should ride slightly high on the cornea and tuck under the upper lid.
2) Gravity should not cause the lens to separate from the upper lid, and this attachment should result only from the lens-lid interaction, not from the base curve (BC) to cornea relationship.
3) Patients must perform complete blinks.
4) This type of blink needs to be trained to avoid orbicularis oculi spasms.
5) Lens movement is to occur during the blinking action, and the lens should move straight down from its superior position.
6) A lens diameter should be used to allow maximum corneal exposure, the lens edge should be as thin as possible, and the edge shape should have the apex displaced anteriorly.[7]

The second fitting method is known as the Bayshore Technique. It consists of several key aspects of lens design essential to an optimal fit:

1) The diameter of the lens should fit completely within the interpalpebral aperture.
2) The BC to cornea relationship must yield apical clearance to provide tear pooling.
3) The second curve is an average of 0.8mm flatter radii than the BC. This is known as the 'fitting curve'. It's relationship to the cornea determines the movement and positional characteristics of a lens, not the BC.
4) Finally, the edge bevel should be 0.1mm wide and 17.0mm radius. This is done to create a more stable lens through the blinking phase and acts to fuel the tear pump.[8,9,10]

In summary, the Korb method generally uses larger, flatter lenses that are controlled by lid forces, not BC to cornea relationships.[11] As the individual blinks, the lens translates and rocks along an area of bearing, thus providing tear exchange. In contrast, the Bayshore Technique uses smaller, steeper lenses that must fit completely between the lid margins, relying entirely upon BC (and more importantly secondary curve) to cornea forces to support the lens position. Central pooling combined with a beveled edge is the source of the tear pump with each blink. Both of these methods rely heavily on peripheral cornea factors to generate an optimal fit, but neither philosophy designer had the luxury of actually knowing what the peripheral cornea looked like when they developed them. The clinicians who developed them used their intuition, experience, and years of careful observation of fluorescein patterns to form their fitting theories.

In the mid 1980's, videokeratography became available to eye care practitioners. Modern videokeratography projects circular Placido rings onto the cornea and their image is captured by video camera(s). A computer then reconstructs the rings, and using an algorithm, creates a color topographical map which represents the three-dimensional shape of the cornea. One can choose from several choices of data display, including diopter-point plots, isometric display, and color-coded contour maps, to name just three. This type of imaging has proved useful in the diagnosis of several corneal diseases, keratoconus being the most prominent.[12] Specifically, ophthalmologists have utilized modern videokeratography to aid them in refractive surgical procedures.[13] Optometrists, like their predecessors, recognized an opportunity to use the technology of videokeratography to advance the ability, predictability and success of fitting contact lenses, primarily rigid lenses.

In the US, there are four major Placido image based systems: Tomey TMS, Alcon EyeMap, EyeSys Corneal Analysis System (CAS), and Humphrey

MasterVue . This study deals with the latter two, EyeSys and MasterVue. Both systems, in addition to the many features previously described, are equipped with software capable of generating lens parameters for an RGP fit. Naturally, each computer uses a different fitting philosophy for the creation of lens parameters.

The EyeSys CAS has three fitting modes for normal corneas: apical clearance, alignment, and aspheric. For this study, all patients were fit in the alignment mode. To generate an RGP fit for a patient with the EyeSys computer, an examiner must simply enter the patient's prescription, take a corneal reading (edit any aberrant findings due to lids/lashes etc.), then enter the visible horizontal iris diameter and pupil diameter. Next, the computer will generate lens parameters according to the following guidelines:

1) The base curve is selected according to the following nomogram.

Table 1. Nomogram for Ordering the Central Radius of Curvature in the Alignment Fitting Technique.

Degree of corneal astigmatism	Base curve
0 to 0.50 D	"K" - 0.50 D
0.50 to 1.00 D	FLAT "K" - 0.25 D
1.00 to 1.50 D	ON FLAT "K" D
1.50 to 2.00 D	FLAT "K" + 0.25 D
2.00 to 3.00 D	FLAT "K" + 0.50 D
> 3.00 D	DELTA "K"/4

*If the corneal astigmatism is greater that three diopters, a warning message appears that recommends consideration of a toric lens design.

2) The lens overall diameter (OAD) is dependent on both the horizontal visible iris diameter as well as the pupil size. Both are measured by the investigator using a millimeter grid overlay of the eye image, and then entered into the computer. To calculate the OAD, the software takes the visible horizontal iris diameter (entered by the examiner) and subtracts 2.6 mm. It then rounds this value either up or down to 8.4mm or 9.4mm, which ever value is closest.

3) Optical zone (OZ) diameter is then calculated by taking the OAD and subtracting 1.4mm *or* it is set equal to the BC, which ever is smaller. For example, if the BC = 7.40mm, then the maximum allowable OZ is 7.4mm. If the OAD was 9.4mm, subtracting 1.4mm would leave the lens with an OZ of 8.0mm. In this case the computer would default the OZ down to equal the BC of 7.4mm.

4) Power is automatically compensated for from the entered prescription for any effects of lens vaulting.

5) Secondary and peripheral curves are determined by each individual's corneal topography. The program averages peripheral ring data at a 22 degree section along the flattest K. The first peripheral curve is determined by adding 0.75 mm to the average radius of curvature of flattest K. The secondary curve is generated by adding 0.75mm to the first peripheral curve. The default width for both curves is 0.3mm.[14]

In contrast, the MasterVue Contact Lens Module chooses a BC and OZ that will optimally provide approximately 1mm of mid peripheral bearing horizontally, beginning at approximately 3mm from center (with-the-rule cornea) and freedom for the lens to translate vertically. Note obviously, that an against-the-rule cornea requires a back toric design to achieve this relationship.

The computer generates lens parameters by analyzing the cornea in the following manner:

1) It identifies the center of the Placido image (line of sight).

2) Next it measures 3mm temporal to the line of sight and selects 7 points along a vertical line through that point at 5° intervals. As is shown in Figure 1.

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  OCLC:  NEW                       Rec stat:    n
  Entered:     19961004            Replaced:    19961004       Used:    19961004
U Type:  a      ELvl:  I      Srce:  d      Audn:          Ctrl:          Lang:  eng
  BLvl:  m      Form:         Conf:  0      Biog:          MRec:          Ctry:  xx
                Cont:  b      GPub:         Fict:  0       Indx:  0
  Desc:  a      Ills:  a      Fest:  0      DtSt:  s       Dates: 1995,       Y
U   1  040      Bc OPU Y
U   2  099      THESES Ba OPT Ba Bidegary Ba C M Ba 1995 Y
U   3  049      OPUM Y
U   4  100 1    Bidegary, Cynthia M. Y
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Bidegary, John P. Huard. Y
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U   7  300      [46] leaves : Bb ill. ; Bc 28 cm. Y
U   8  502      Thesis (O.D.)--Pacific University, 1995. Y
U   9  504      Includes bibliographical references (leaves 36-37). Y
U  10  650  0   Computer assisted videokeratography. Y
U  11  690      Pacific University theses, Bx College of Optometry, Bx Doctor of
Optometry. Y
U  12  700 1    Huard, John P. Y
U  13  949 10   Bb 35369000780435 Bc POPT Bd THESES OPT Bidegary C M 1995 Bt
POPT Y
U  14  949 10   Bb 35369000780427 Bc PARCH Bt PARCH Y
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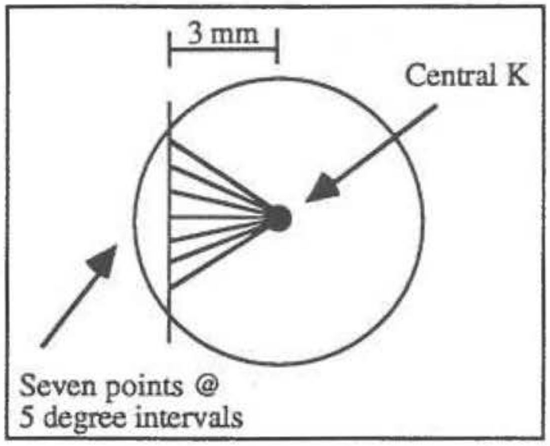
Figure 1.



The numerical average of these seven values becomes the target BC.

3) In early software versions, the computer took measurements 3mm superior and inferior to central K to verify that there was at least 0.50 D of clearance for the lens to move vertically. However, there exists a potential in these zones for artifacts in the mires caused by lids, lashes, and brows. These artifacts essentially cause the computer to measure pseudo-flattening of the superior/inferior cornea. This would then cause the software to unnecessarily flatten the BC to compensate. To avoid such problems, we disabled the superior/inferior measurement feature, and assumed that clearance was present. This modification has now been made to the current MasterVue software.

4) Power is automatically compensated for from the entered prescription for any effects of lens vaulting.[15,16]

The purpose of this investigation was to compare the initial (dispensing visit) objective and subjective differences between an EyeSys and MasterVue generated RGP lens fit. Objectively the investigators graded visual acuity, lens alignment, edge pattern, apical pattern, and over refraction. Subjectively, via a survey, subjects graded the lenses in terms of clarity of vision, comfort and overall preference.

Methods

Subjects were solicited via a printed advertisement in the greater Portland, Oregon area. They were offered a free pair of RGPs for their participation in the study. Twenty nine people were included in the initial fitting. Due to scheduling difficulties, 5 individuals were dropped and were not dispensed lenses for the purpose of the study.

All subjects were required to undergo a comprehensive optometric examination prior to inclusion in the study. Eligible subjects had to be free of systemic or ocular disease that contraindicated rigid contact lens wear. All subjects had to be myopes, with a sphere power no greater than -10.00 D. Refractive cylinder no greater than 3.00 D was allowed. Anisometropia greater than 2.00 D was exclusionary. Difference in central keratometry readings (Δ K) no greater than 2.00 D was allowed. No consideration of previous contact lens wear was used as exclusion criteria. See Figure 2 for distribution of subject's contact lens history. A written informed consent document was obtained from each subject prior to initiation into the study. Subjects who chose to continue wearing the lenses after the study were required to purchase and sign a one year contract of follow-up care at a reduced research fee from the Pacific University Family Vision Center. Participants were also given the option of signing a waiver to see their own eyecare professional for all follow-up care.

The 24 subjects for whom lenses were dispensed ranged in age from 16 to 41 with a mean age of 26.4 years. There were 12 males and 12 females. The average age of males was 26.5 and the average age of females was 26.3. See Figure 3. Gender and age distributions are shown in Figure 4. Sphere refractive errors ranged from plano to -7.00 D with an average value of -2.84 D. Anisometropia ranged from zero to 2.00 D, with an average of 0.43 D. Anisometropia distributions are shown in Figure 5. The power of refractive cylinder ranged from spherical to -2.75 D, with an average of -0.56 D. OD average sphere was -2.88 D, and average cylinder was -0.56 D. OS average sphere was -2.81 D, and average cylinder was -0.56 D. Corneal cylinder ranged from spherical to 1.75 D, with an average ΔK of 0.63 D. Difference in ΔK between eyes ranged from zero to 1.75 D, with an average difference of 0.36 D. See Figure 6. The anisometropia and difference in ΔK numbers are especially important since the study revolves around objectively and subjectively comparing the performance of the RGP lenses on the right and left eye of each subject.

The RGP lenses used in the study were from the fluoro-silicone acrylate family (Boston 7, Polymer Technology Corp.) Initial reports of the Boston 7 material have been positive. Advantages include enhanced wetting, deposit resistance, and an excellent daily wear Dk/L (49 @ 0.15 mm CT). The contact lens buttons were donated by Polymer Technology Corporation and were manufactured by Opti-Craft/Omega of Portland, Oregon.

Twenty nine subjects had corneal mapping done on each eye by both the EyeSys and the MasterVue. In addition, each computer generated a best fit lens for each eye. For the purposes of this study no manual changes in the lens parameters were allowed. Next, the investigators randomly chose one eye to receive the EyeSys lens and one eye to receive the MasterVue lens. Lenses were ordered from Opti-Craft and verified upon arrival.

24 hours prior to the dispensing date, the lenses were cleaned with Miraflow Daily Cleaner, rinsed in tap water, and stored in Allergan Wet-N-Soak Conditioning Solution. This procedure was done to every lens to insure acceptable and consistent wetting status at the time of dispense.

All dispensing exams for the remaining 24 subjects were done in the same room with a calibrated keratometer, Snellen acuity chart, and were administered by the same team of investigators. Neither the investigators nor the subjects were aware of which eye was fit by which computer. The dispensing exam consisted of a standardized protocol of testing:

1) Entering habitually corrected distance VA (not always the same as best visual acuity)

2) Keratometry

3) RGP lens insertion

4) 5 minute post-insertion VA

5) Spherical Over-refraction. If VA was poorer than best VA, a sphere-cylinder over-refraction was performed.

6) Fluorescein dye was applied to each eye and the fit was assessed by both investigators. The investigators then graded the lens performance in terms of visual acuity, alignment, edge pattern, apical pattern, over-refraction, and overall performance. (Table 2.)

7) Each subject filled out a survey (Table 3.), in which they graded each lens in terms of visual acuity, comfort, and overall preference.

8) The lenses were removed with a DMV brand contact lens remover. The fit and options were discussed with each subject.

In addition the lenses were evaluated using a modified 3 point scoring system to give a cumulative score of all physical characteristics and measures of optical accuracy. Physical fitting characteristics were composed of lens position, apical pattern and edge pattern. See Table 4. Optical accuracy was scored in terms of visual acuity and over-refraction. See Table 5. In both situations, the lowest score earned in each category determined the level for that lens.

Results

This study compared subjective and objective differences at the dispensing visit of the two computer generated lenses. Subjectively the last question that each patient answered was which lens they preferred overall. Of the 24 subjects, 4 chose the EyeSys lens (19%), 15 chose the MasterVue (57%), and 5 had no preference (24%). See Figure 7. Interestingly, of the 5 undecided, 4 were male. The sexes were split equally in the EyeSys group. The MasterVue, in contrast, was preferred more by females (9), than by males (6). See Figure 8.

A major difference in the initial preference of a given RGP lens was noted based on previous contact lens experience. The EyeSys preferred lenses (4), were all chosen by people who currently or in the past had worn soft contact lenses (SCLs). Of the 15 MasterVue lenses chosen, 10 individuals (67%) had an RGP history, 4 (26%) had a SCL background, and 1 (7%) had no contact lens exposure. See Figure 9.

Another factor leading to the decision about overall preference is clarity of vision. Over-refraction (O-R) is a good indicator concerning how the decision of clarity is made. The distribution of O-R is displayed by Figure 10. The EyeSys had an average O-R of +0.104 D, with a range of +2.00 to -1.00 D. The MasterVue had an average O-R of -0.177 D with a range of +0.50 to -0.75 D. As is shown by Figure 11, nearly three quarters (74%) of the lenses chosen had either plano or -0.25 D for an O-R. Subjectively in terms of quality of vision, the patients rated the EyeSys lenses with an average grade of 3.63 (1=Great, see better than ever before: 5=Unacceptable, vision too poor to wear the lens). See Table 3 for a complete description. Conversely they gave the MasterVue an average grade of 3.29. This amounts to a 0.34 difference in favor of MasterVue, however this amount is not statistically significant.

Comfort will obviously contribute to a decision on overall preference. Aspects of lens design that contribute to comfort are multi-fold. We have analyzed two, the first being OAD. The OADs for all the EyeSys lenses averaged 8.73mm, with diameters being either 8.40 or 9.40mm. The OADs for the MasterVue lenses averaged 9.39mm, with a range of 9.00 to 9.80mm. See Figure

12. This amounts to a 0.65mm average OAD difference, MasterVue being larger. Of the lenses preferred, the average OAD was 9.25mm with a distribution of 8.40 to 9.70mm. See Figure 13. Another classical way to examine lens comfort is the lens BC to central flattest keratometry (K_f) relationship. The distribution of BC to K_f for each computer is displayed by Figure 14. The graph demonstrates that the majority of EyeSys lenses were fit steeper than K_f, and conversely the majority of MasterVue lenses were fit flatter that K_f.

Subjectively both lenses were graded by each individual in terms of comfort. The EyeSys lenses received an average grade of 3.25. The MasterVue lenses got an average grade of 2.75. This amounts to a 0.50 difference in favor of MasterVue, that is significant to the level of P=0.008.

Objectively the lenses were graded in terms of six categories:

Table 6. Objective Grading Results.

Category	Computer	Average Grade	Difference in favor*
VA	EyeSys	3.71	
	MasterVue*	3.42	0.29
Lens Position	EyeSys	2.13	
	MasterVue*	1.88	0.25
Edge Pattern	EyeSys	1.83	
	MasterVue*	1.71	0.12
Apical Pattern	EyeSys*	1.58	0.13
	MasterVue	1.71	
Over-Refraction	EyeSys	2.92	
	MasterVue*	2.79	0.13

This table demonstrates that objectively the MasterVue lenses numerically out performed the EyeSys lenses in 4 of the 5 categories.

Statistics were performed on the data using the Wilcoxin signed-rank test. The null hypothesis for this test is that the distribution of observations between the two conditions are identical. The results of the P values are in the following table, note that a P value ≤ 0.05 is needed to obtain statistical significance.

Table 7. P values from Wilcoxin signed-rank Test of Objective Grading.

VA	P=0.5839
Lens Position	P=0.0613
Edge Pattern	P=0.4386
Apical Pattern	P=0.5385
Over-Refraction	P=0.7564
*Note that all P values are displayed with Z corrected for ties.	

This demonstrates that there is no concrete statistical difference in the performance of the EyeSys and MasterVue lenses in each of the six categories. Only visual acuity and final outcome approached a significance level.

Table 8. P values from Wilcoxin signed-rank Test of Subjective Grading.

Clarity of Vision	P=0.1346
Physical Comfort	P=0.0080
*Note that all P values are displayed with Z corrected for ties.	

Subjectively, the statistics determine that only comfort was significant, and that vision approached but did not reach significance.

The overall preference choice of the group was evaluated from random distribution using a one group Chi-Square test. The one group Chi-Square's null hypothesis is that the distribution is due to randomness. The probability of the distribution being random in these subjects was 0.0605. This very nearly meets the 0.05 cutoff for statistical significance.

When the data was examined using the modified performance grading scale, we were looking for the distribution of optimal, acceptable and marginal outcomes from two standpoints: physical and optical performance. The results are shown in Tables 9 and 10. The graphical distributions are displayed in Figures 15 and 16.

Discussion

The essential question of this investigation was which computer aided topographical system would generate the best RGP lenses from both an objective and subjective standpoint, EyeSys or MasterVue? As is shown by the results, the MasterVue lenses were preferred by the patients overall. The level of preference was not shown to be statistically significant, however. In our analysis of the data, we have examined variables that could explain this basic overall preference for MasterVue generated RGPs.

The data shows a statistically significant subjective physical comfort difference in favor of MasterVue lenses. We hypothesize that of all the physical variables, OAD had the greatest influence on initial comfort. There was a direct correlation between size of the lens and the patients comfort: the larger the OAD, the easier it was for them to initially adapt to the lens being on their eye. This phenomenon has been collaborated by previous investigators. [17]

The data also shows that MasterVue lenses had an overall physical performance advantage, in terms of lens position, apical pattern and edge pattern.

Furthermore, in the comments section of the survey the most frequently mentioned complaint against the smaller (typically EyeSys) lenses was that of monocular diplopia. We conclude that the combination of lower physical performance score for the EyeSys lenses, (characterized by low a riding position), and the relatively small optic zones for their position on the eye, is the root of the complaints against the EyeSys lenses. It was common for the optic zone blends of the EyeSys lenses to partially bisect the subject's pupil.

Our review of the actual EyeSys images used to generate the lens fits have led us to the following conclusion. A main reason the computer produced a poorly fit lens was due to a poor eye image. For example, two of the outliers whose lenses were over 2.00 diopters flatter than K_f, had blurry eye images. Therefore we conclude that careful inspection by the operator of each eye image is critical for accurate lens parameter determination. Furthermore, having the operator inspect each eye's image would also serve to note any large asymmetry between eyes (as was the case with the two outliers). Since it is known that the corneas of the OD and OS are typically mirror images of the other, large deviations should raise a red flag. We also speculate that because these individuals had light irides, perhaps the computer had difficulty dealing with low levels of contrast when it attempted to generate a map.

Despite what the EyeSys literature states concerning pupil size as a determining factor when choosing an OAD, we found this not to be true. *Only* horizontal visible iris diameter had an effect on the computers choice for OAD: if the iris was > 12.00mm a 9.40mm diameter was used, if <12.00mm then 8.40mm was chosen, (regardless of what pupil size was entered: 2.0 to 8.0mm). This explains the majority of 8.40mm OADs generated by EyeSys since the majority of individuals have a horizontal visible iris diameter less than 12.00mm.

The compounding problem of using the 8.40mm lenses was that the computer used the same BC nomogram for both 9.40 and 8.40mm lenses. See Table 1. The end result of this is that the 8.40mm lenses were nearly always fit flatter than K_f. Recall that the results showed that the EyeSys lenses rode excessively low (causing monocular diplopia in several individuals). As is know by many, and described in great detail by Bayshore, smaller diameter lenses need to be fit slightly or moderately steep for them to properly center.

Our recommendations for using the MasterVue system are essentially the same as for the EyeSys. It is equally important when using this computer to carefully obtain and inspect the eye images. Errors were typically linked to poor data resulting from poor image quality, (out of focus, eyelash shadows, etc.).

In addition to these obvious suggestions, we found that inspection of the MasterVue simulated fluorescein pattern proved to be extremely valuable. Although the lens generated by the software was intended to bear mid peripherally as we previously described, the simulated fluorescein pattern would often not have the expected bearing areas. Retrospectively, we manually altered the lens BC until the fluorescein pattern became the ideal for the MasterVue philosophy. We did this to lenses that did not fit well, and the new BC that produced the ideal fluorescein pattern made more clinical sense. It seems a logical approach for the software to automatically do the very same comparison that we did manually, prior to producing the final prescription, and we suggest this modification for future software versions.

Recommendations

Currently, in our judgment, the performance level of available computerized topographical systems for the fitting of contact lenses is limited. However, with heightened anticipation of the ongoing changes in our health care system, computerized topography can have a significant influence on the future of contact lens fittings. Previous studies have established that, on average, computerized topographical systems have approximately a 60-70% success rate for RGP fits as compared to diagnostic fits by practitioners which are successful 90^{+} % of the time. Although this technology is not likely to replace the optometrist in the fitting of contact lenses, it does have the potential to optimize the doctor's time. Delegation of a majority of the fitting responsibilities to a well-trained technician, aided by a computerized topography system, can increase office efficiency. A technician can complete most of the groundwork of a fit and the doctor can simply finalize the prescription based on the information and performance of a simulated or real RGP lens. By decreasing the time necessary to adequately fit a "run of the mill myope" the doctor will be able to spend additional time with those patients that require more personalized attention.

The cost of this technology is certainly inhibiting for many practices. The hefty price tag would need to be offset by a high contact lens volume within the practice. The ability to be reimbursed for the procedure via insurance billing is also something that one should consider.

Finally, the use of computerized topography may help create the perception of a technologically advanced office in the eyes of the patient population. The interest and enthusiasm generated may contribute to an expanded practice and well-educated patients. This instrumentation can serve as a strong communication tool. The topography print-outs make it easy to demonstrate unusual or unique conditions to both patients and other health professions. Although our findings suggest that you don't need to rush out and purchase a topography system in hopes of replacing ancillary staff and diagnostic lenses, it is none-the-less a valuable tool that has made its entrance onto the scene.

Table 2.

EyeSys vs. MasterVue Fitting Study Protocol
Dispense Objective Grading Scale.

Visual Acuities:

1. **Optimal:** VA is 20/15 or +2 better than BVA.
2. **Good:** VA is 20/20 or equal to BVA.
3. **Acceptable:** VA is two letters worse than BVA.
4. **Marginal:** VA is one line worse than BVA.
5. **Unacceptable:** VA is more than one line worse than BVA.

Lens Position:

1. **Optimal:** Centers from 2-3 with no nasal or temporal decentration (and OZ completely over pupil).
2. **Good:** Centers from 2 to 3 with slight nasal or temporal decentration.
3. **Acceptable:** Centers from at 4 or moderate nasal or temporal decentration but full pupillary coverage.
4. **Marginal:** Centers from 1 to 2 or 4 to 5, or nasal or temporal decentration with minimal pupillary coverage.
5. **Unacceptable:** Lens decenters on eye to degree that edge bisects the pupil.

Apical Pattern:

3. Significant pooling, +/- bubbles.
2. Slight pooling.
1. Apical alignment--even tear distribution.
2. Slight bearing, slight mid-peripheral pooling.
3. Significant bearing, marked peripheral pooling.

Edge Pattern:

3. Very narrow to touch.
2. Slightly narrow or shallow.
1. Optimal.
2. Slightly wide or deep.
3. Very wide, or deep +/- bubbles.

Over-refraction:

1. **Optimal:**	plano
2. **Good:**	+0.25
3. **Fair:**	-0.25 to +0.50
4. **Marginal:**	-0.50
5. **Unacceptable:**	≥+/-0.75

Table 3.
EyeSys vs. MasterVue RGP Fitting Study
PATIENT QUESTIONNAIRE: DISPENSE.

1) Please use the following scale to rate the quality of vision through each lens:

5	**Unacceptable:**	My vision is not good enough to wear the lens. It is much worse than with glasses or with previous lenses.
4	**Marginal:**	I can wear the lens, but my vision is slightly worse than with glasses or previous lenses.
3	**Acceptable:**	My vision is the same as with glasses or previous lenses.
2	**Good:**	My vision is slightly better than with glasses or previous lenses.
1	**Great:**	I can see much better than I ever have.

2) Please use the following scale to rate the **physical comfort** of each lens:

5	**Intolerable:**	I am definitely not able to wear the lens.
4	**Marginal:**	I can possibly wear the lens, but there is significant lens sensation.
3	**Acceptable:**	There is moderate sensation, but I can wear this lens.
2	**Comfortable:**	I have minimal lens sensation.
1	**Very Comfortable:**	I cannot tell the lens is on.

3) Please circle the appropriate response:

Overall, I prefer the lens on my:

RIGHT EYE *LEFT EYE* or *NO PREFERENCE.*

Please feel free to write any comments below.

Table 4. Physical Performance Scoring System.

	Level 1: Optimal	Level 2: Acceptable	Level 3: Marginal
Lens Position	1,2	3	4,5
Apical Pattern	1	2	3
Edge Pattern	1	2	3

Table 5. Optical Performance Scoring System.

	Level 1: Optimal	Level 2: Acceptable	Level 3: Marginal
Visual Acuity	1,2	3	4,5
Over-Refraction	1,2	3	4,5

Table 9. EyeSys Performance Scoring Results, number in each category.

	Optimal	Acceptable	Marginal
Physical Performance	3	6	15
Optical Performance	9	5	10

Table 10. MasterVue Performance Scoring Results, number in each category.

	Optimal	Acceptable	Marginal
Physical Performance	5	9	10
Optical Performance	8	8	8

Figure 2 Distribution of Contact Lens History.

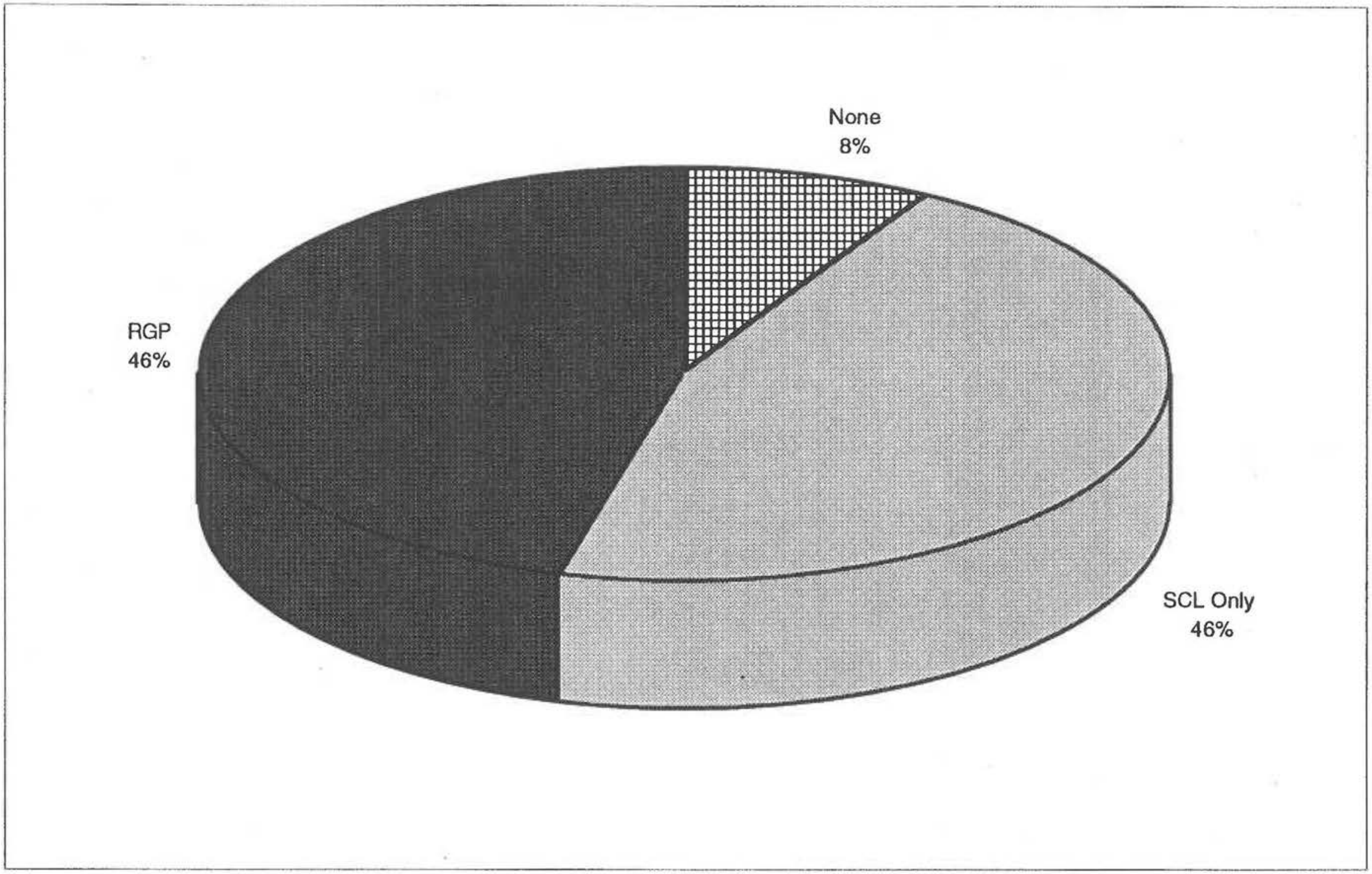


Figure 3. Average Age by Gender.

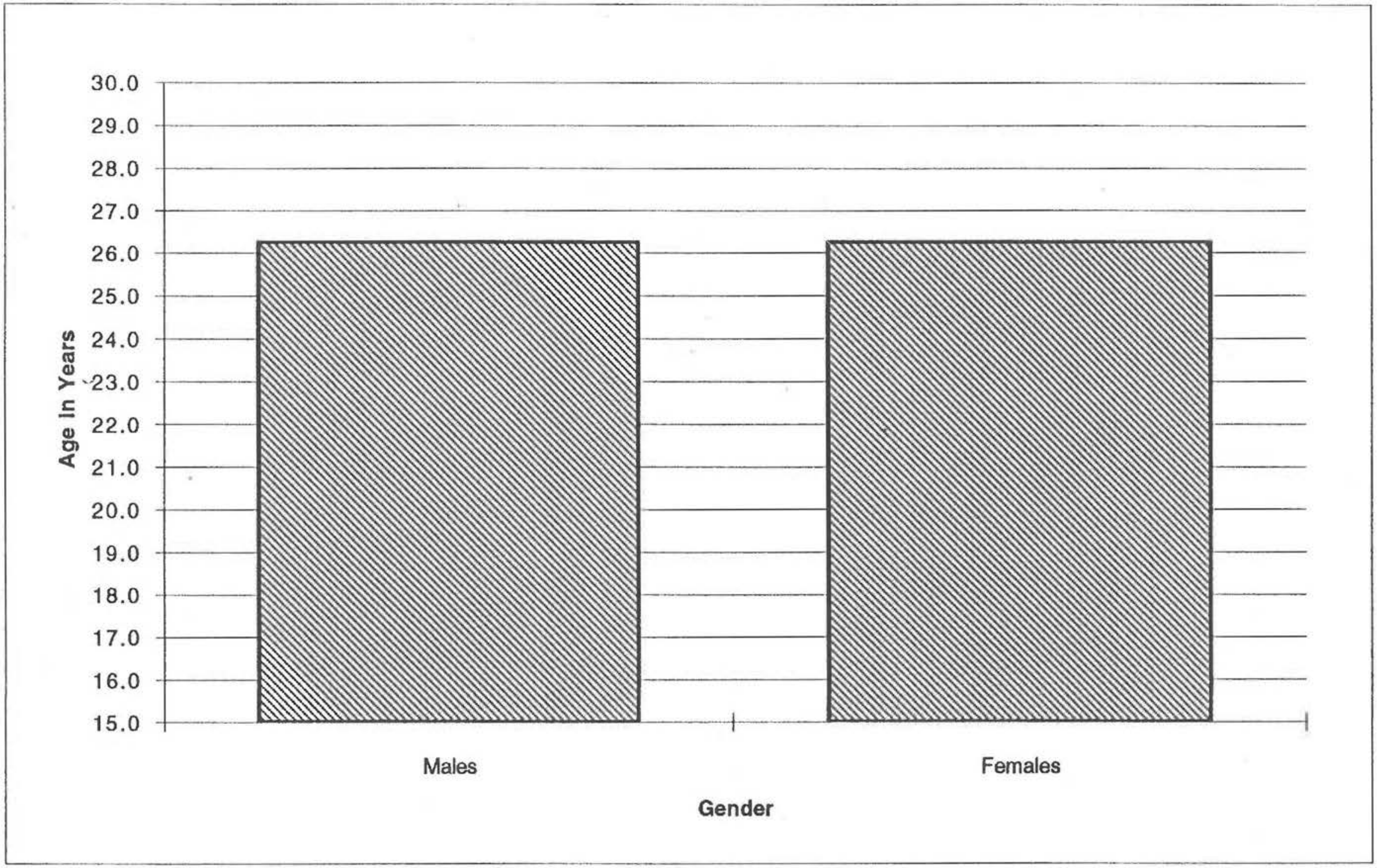


Figure 4. Age Distribution: Male vs. Female.

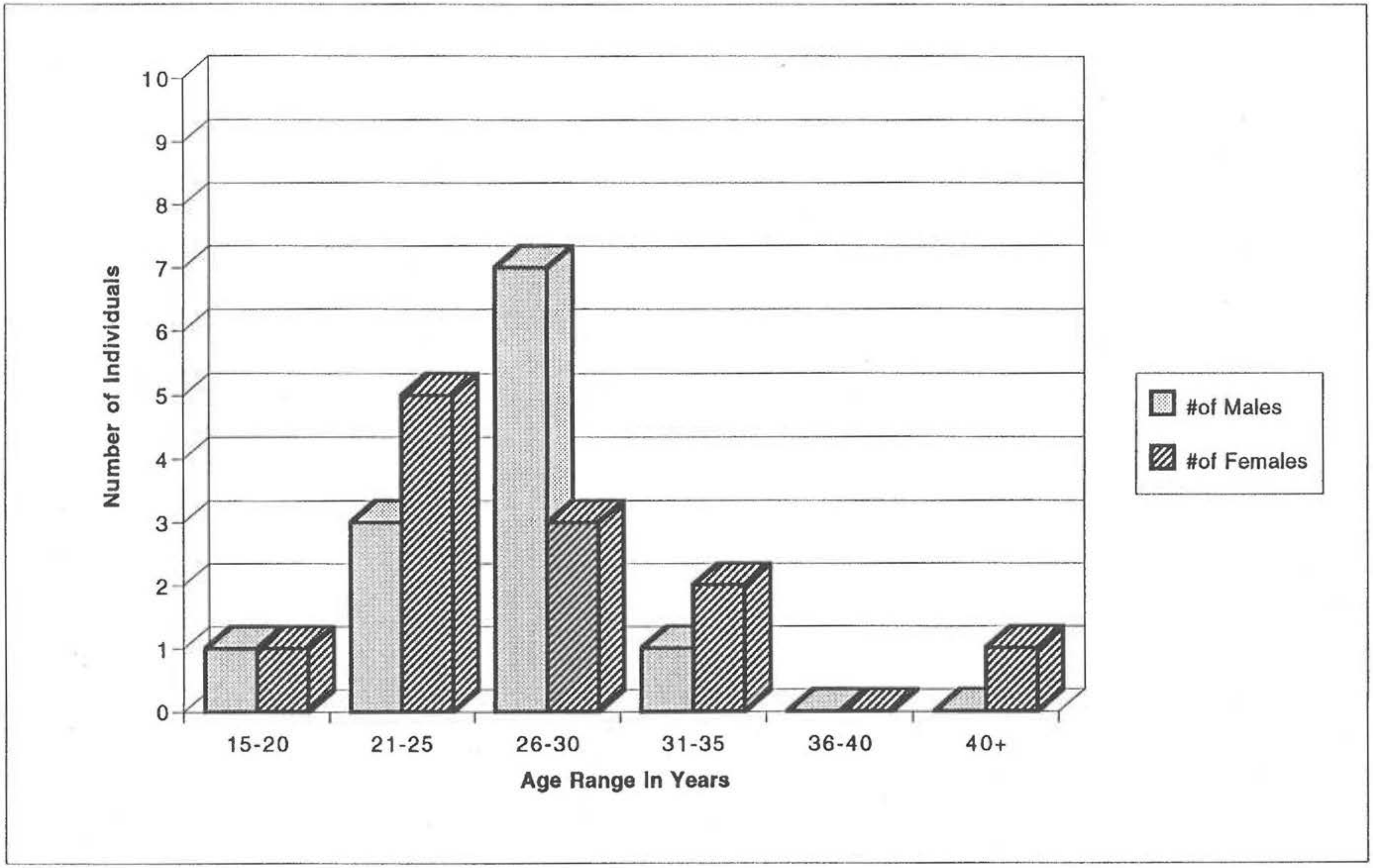


Figure 5. Anisometropia Distribution.

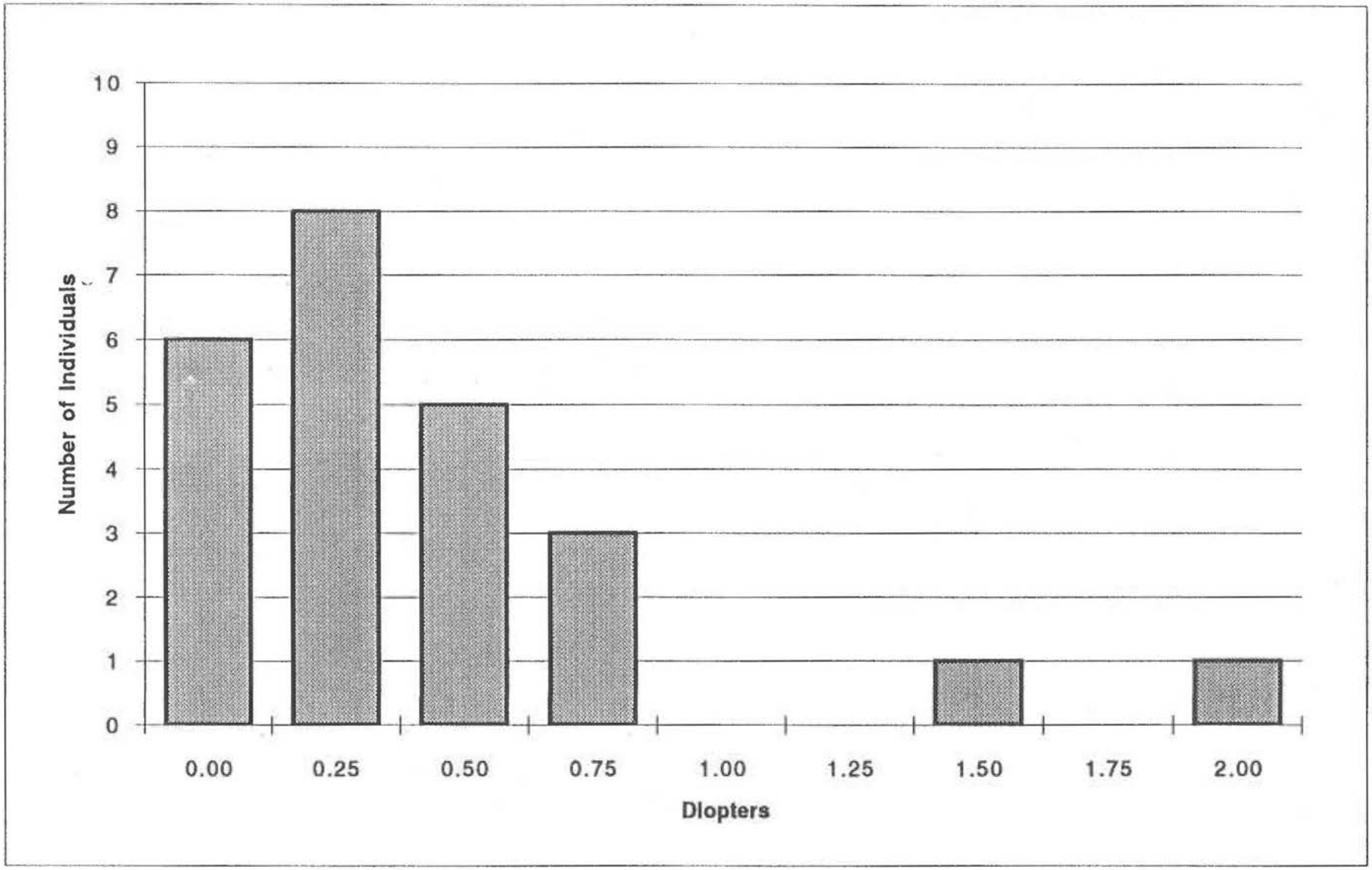


Figure 6. Difference in Delta K Between Eyes.

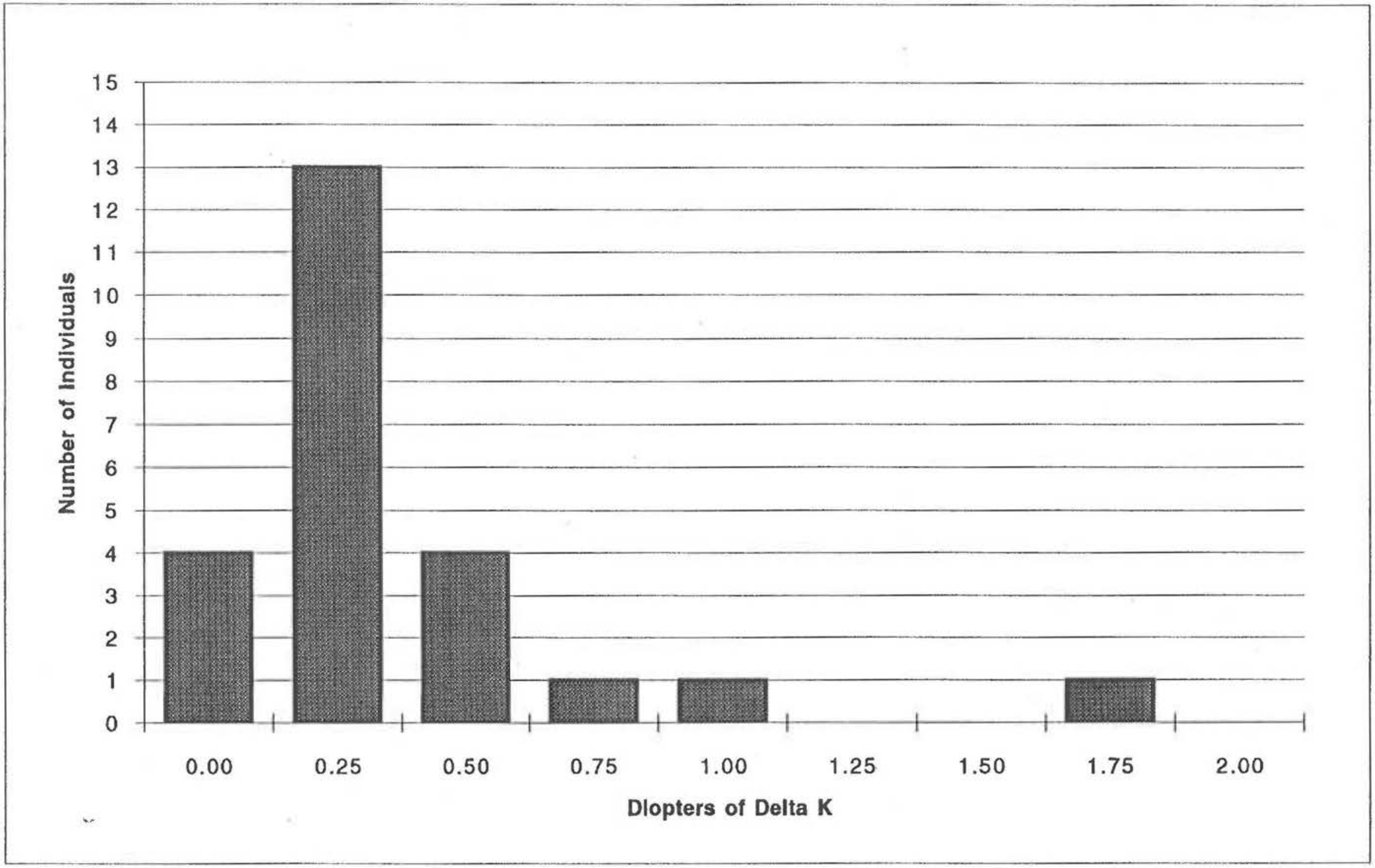


Figure 7. Overall Lens Preference.

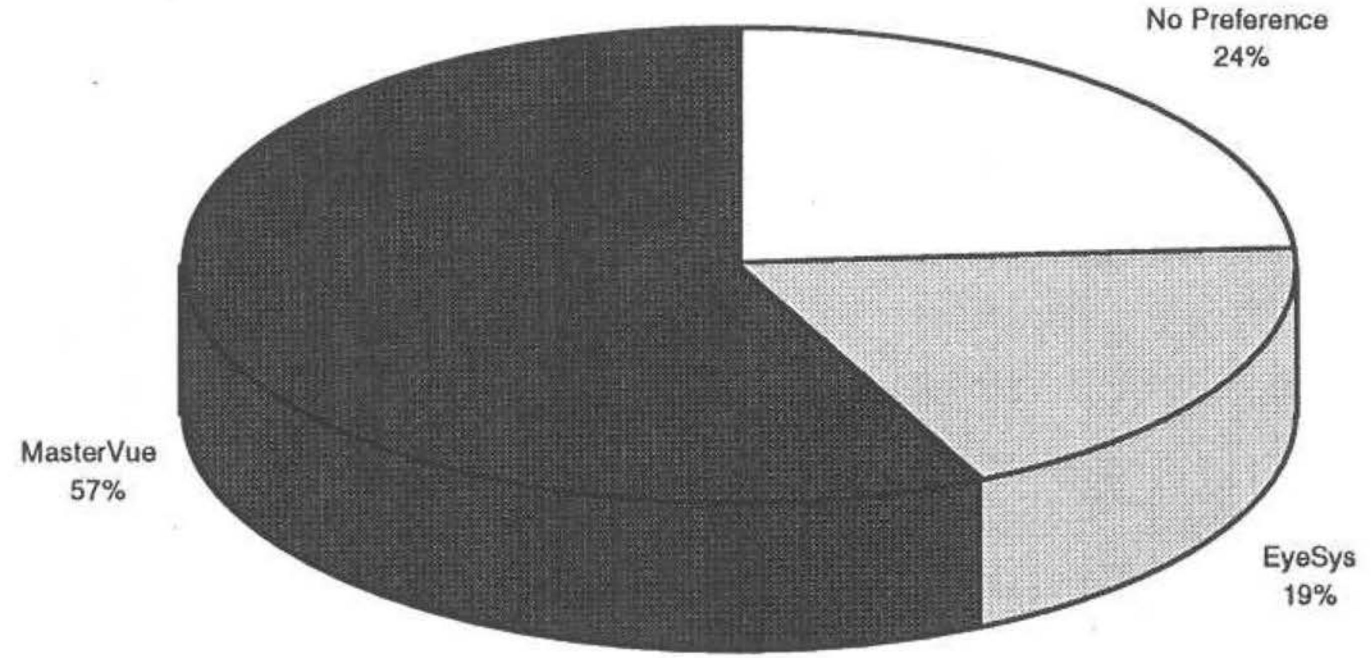


Figure 8. Lens Preference by Gender.

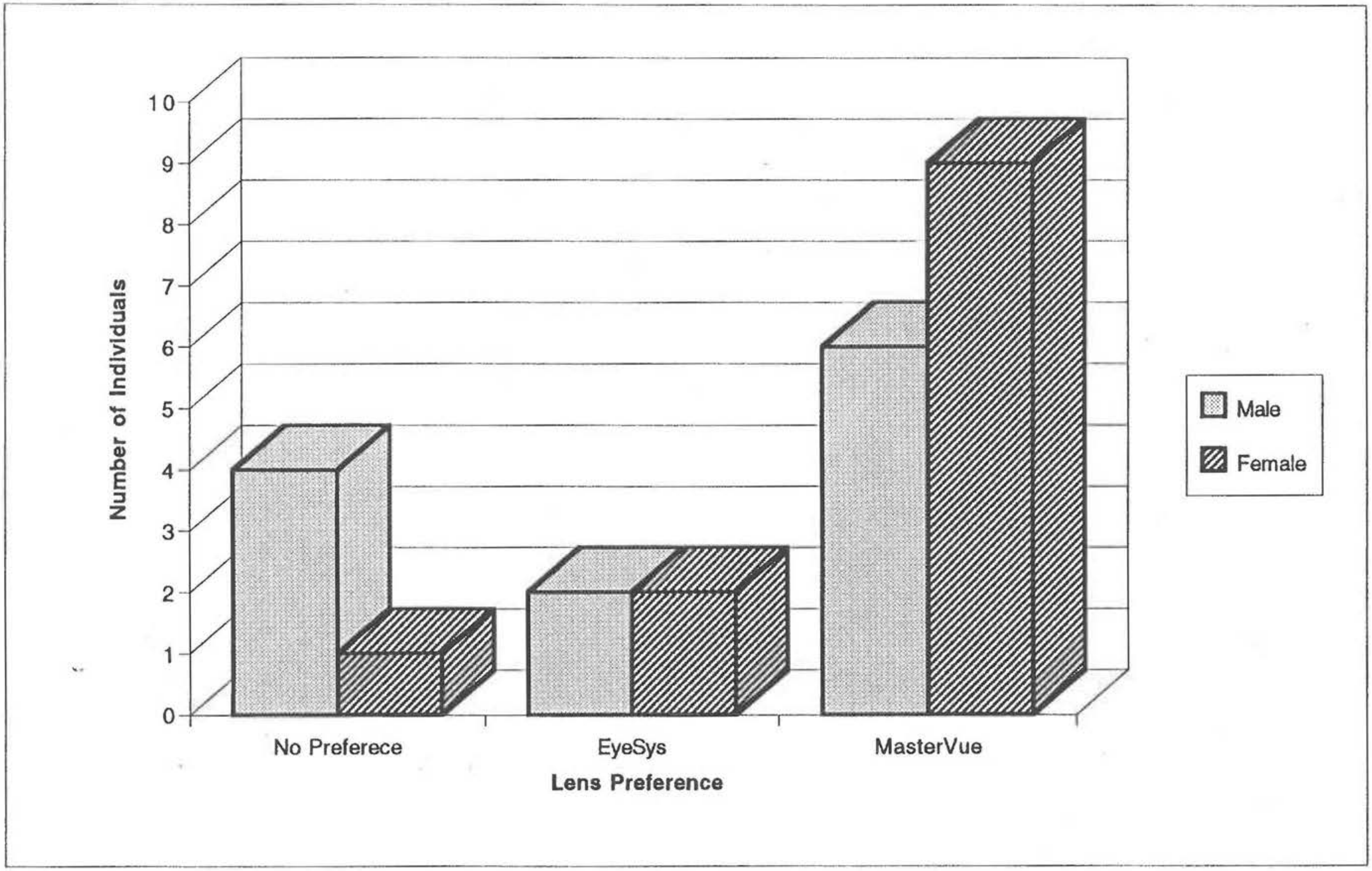


Figure 9. Lens Preference by CL Histoı

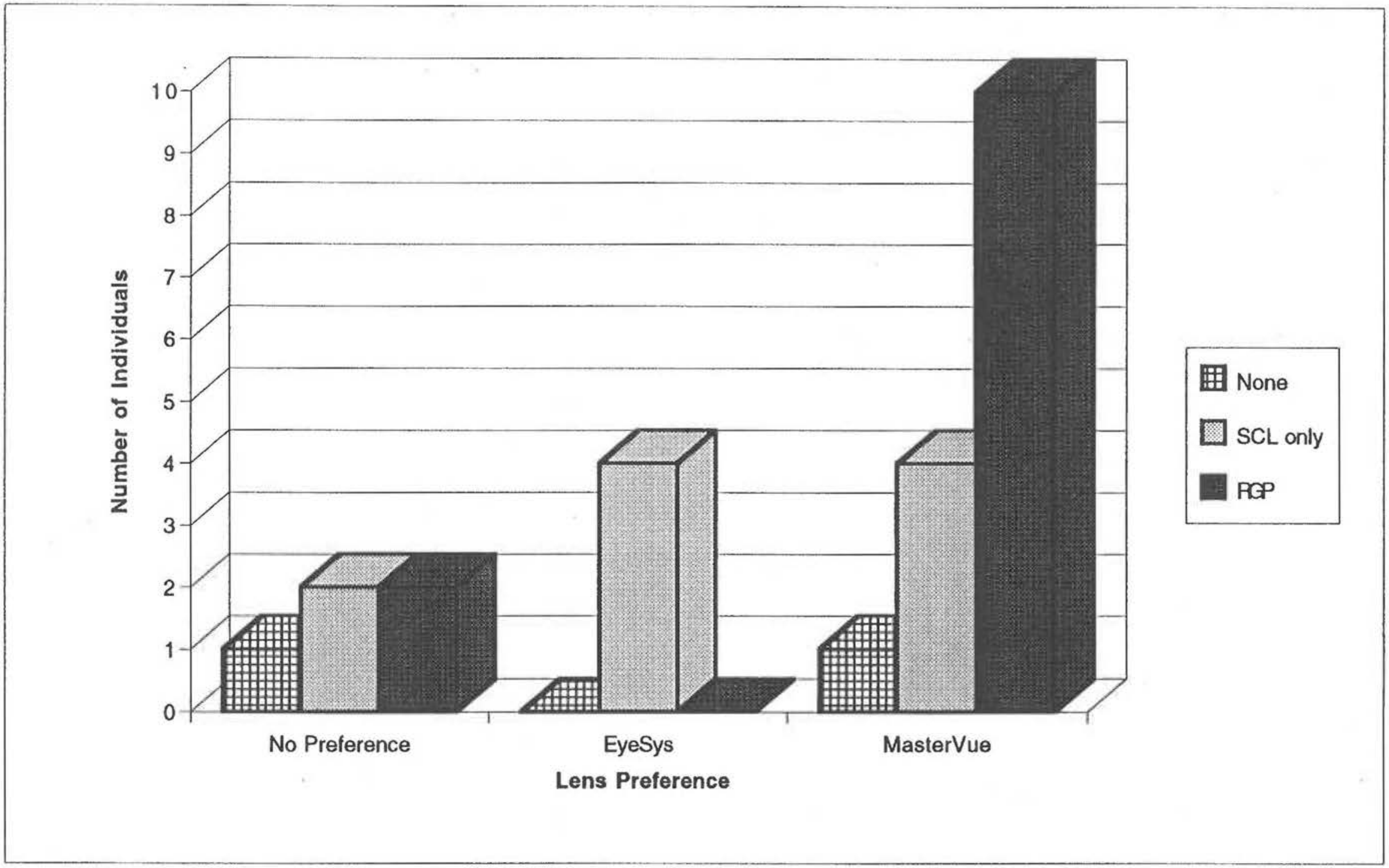


Figure 10. Distribution of Over-Refractions by Computer.

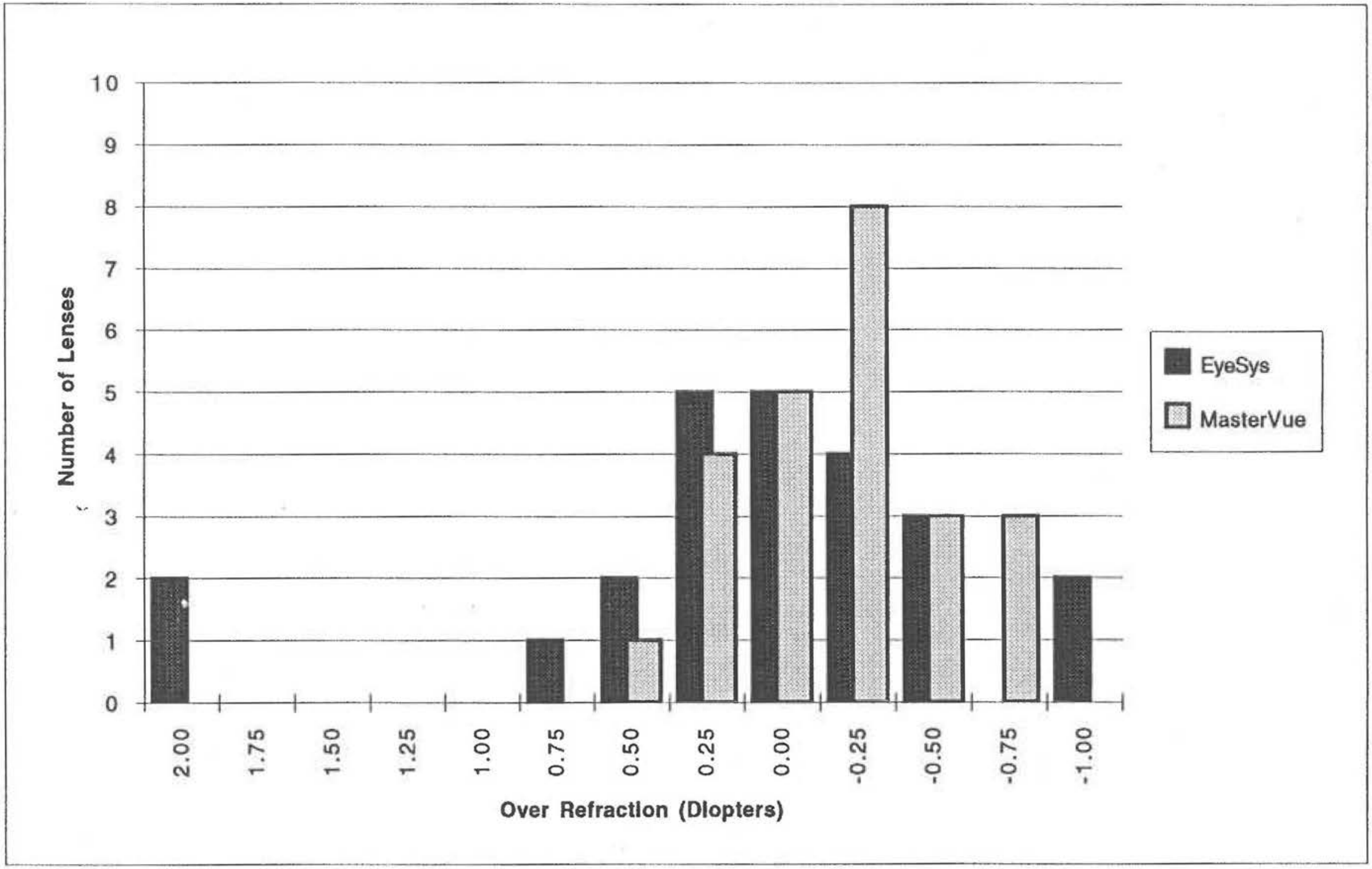


Figure 11. Overall Preference as a Function of Over-Refraction.

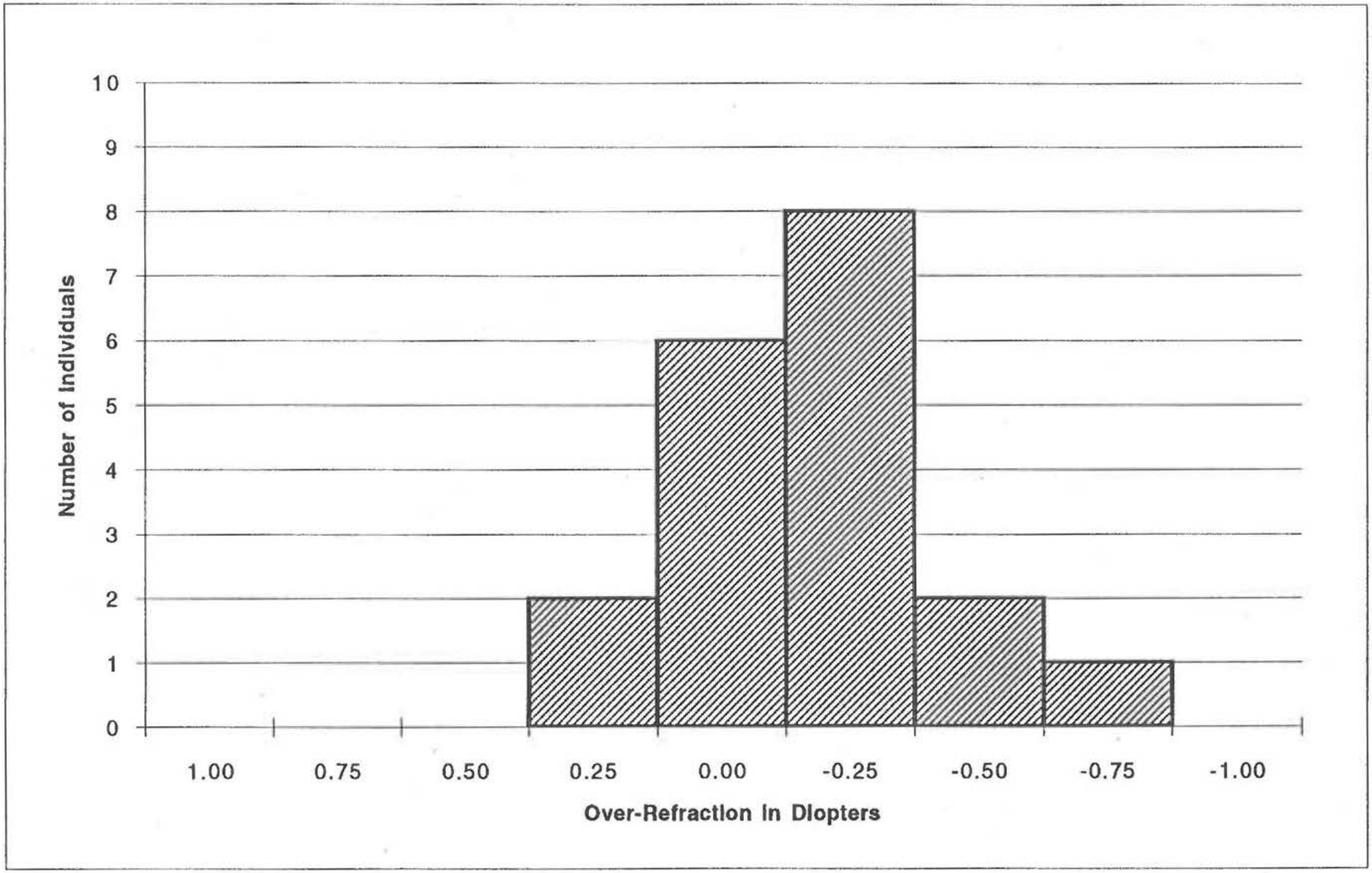


Figure 12. Distribution of OAD by Computer.

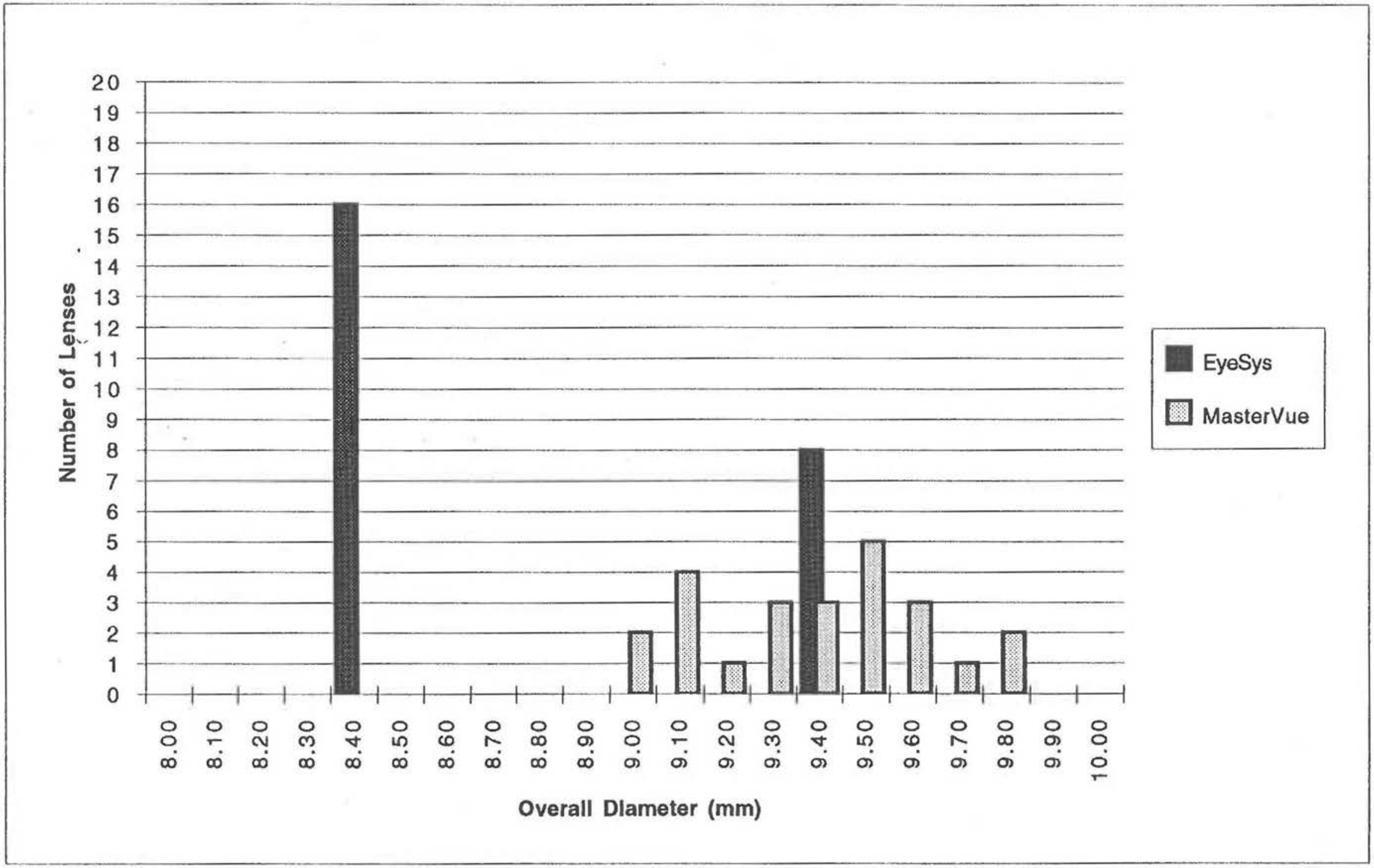


Figure 13. Overall Lens Preference as a Function of OAD.

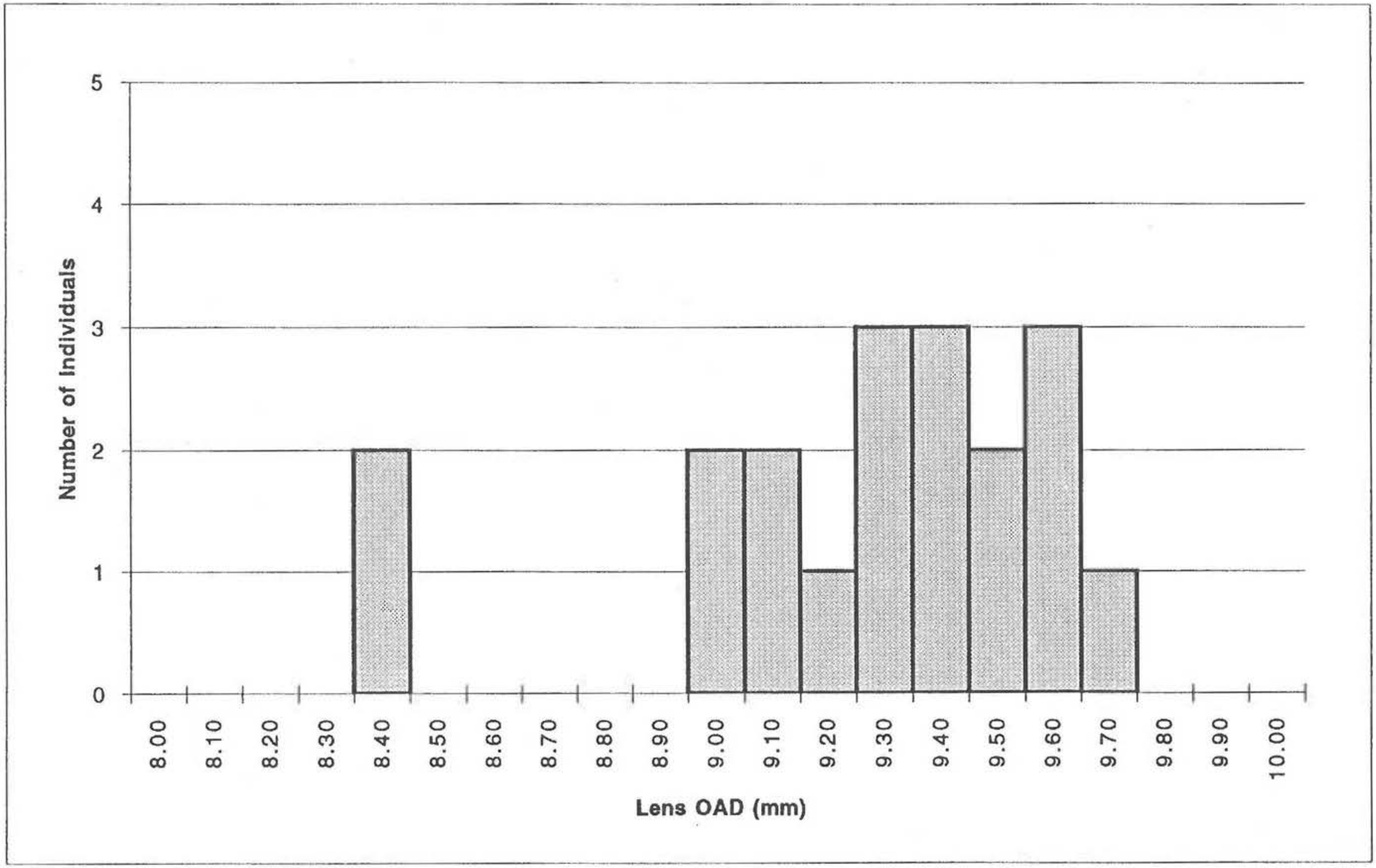


Figure 14. Distribution of BC to K(f) by Computer.

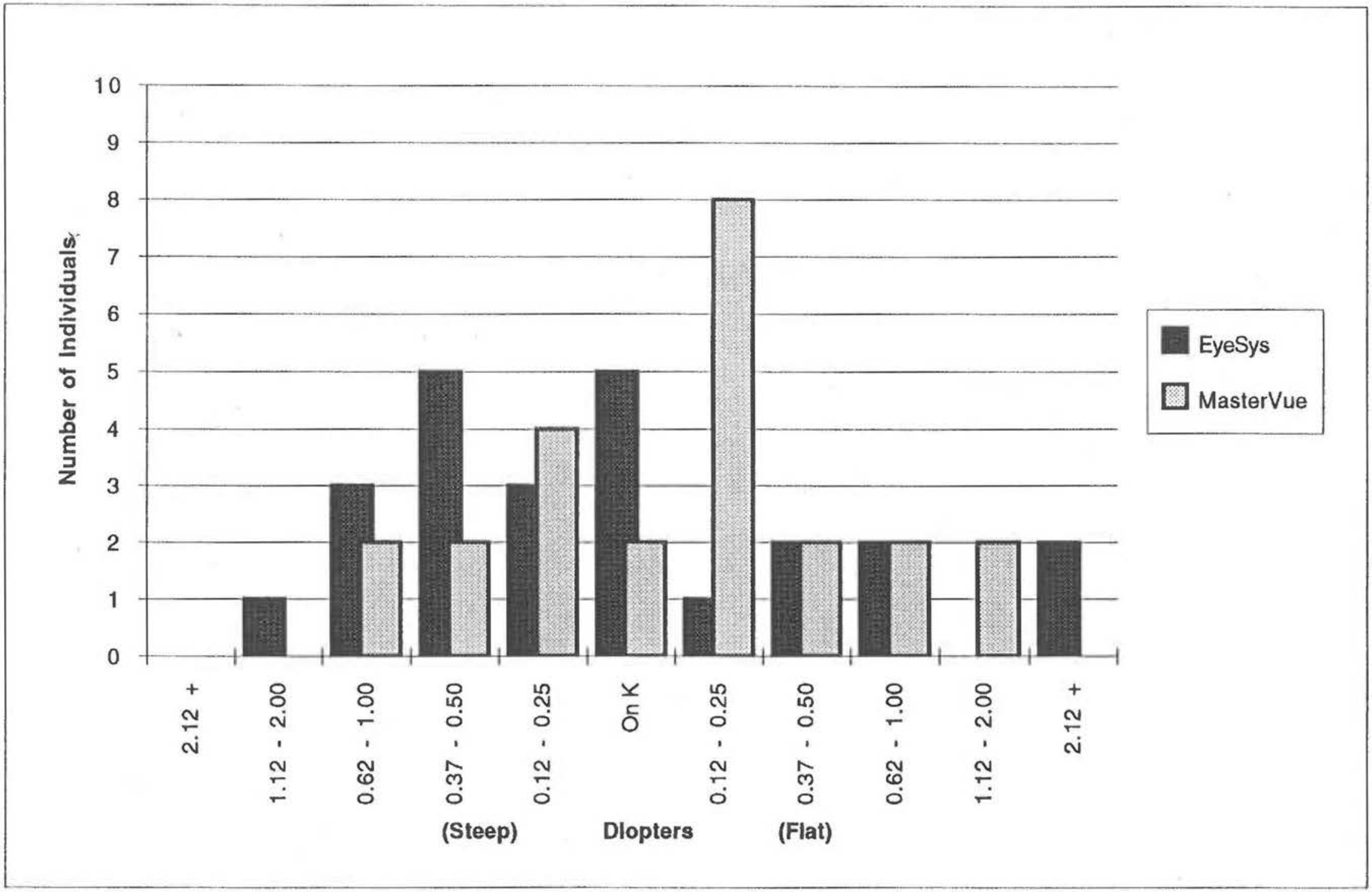


Figure 15. Distribution of Physical Performance Scores.

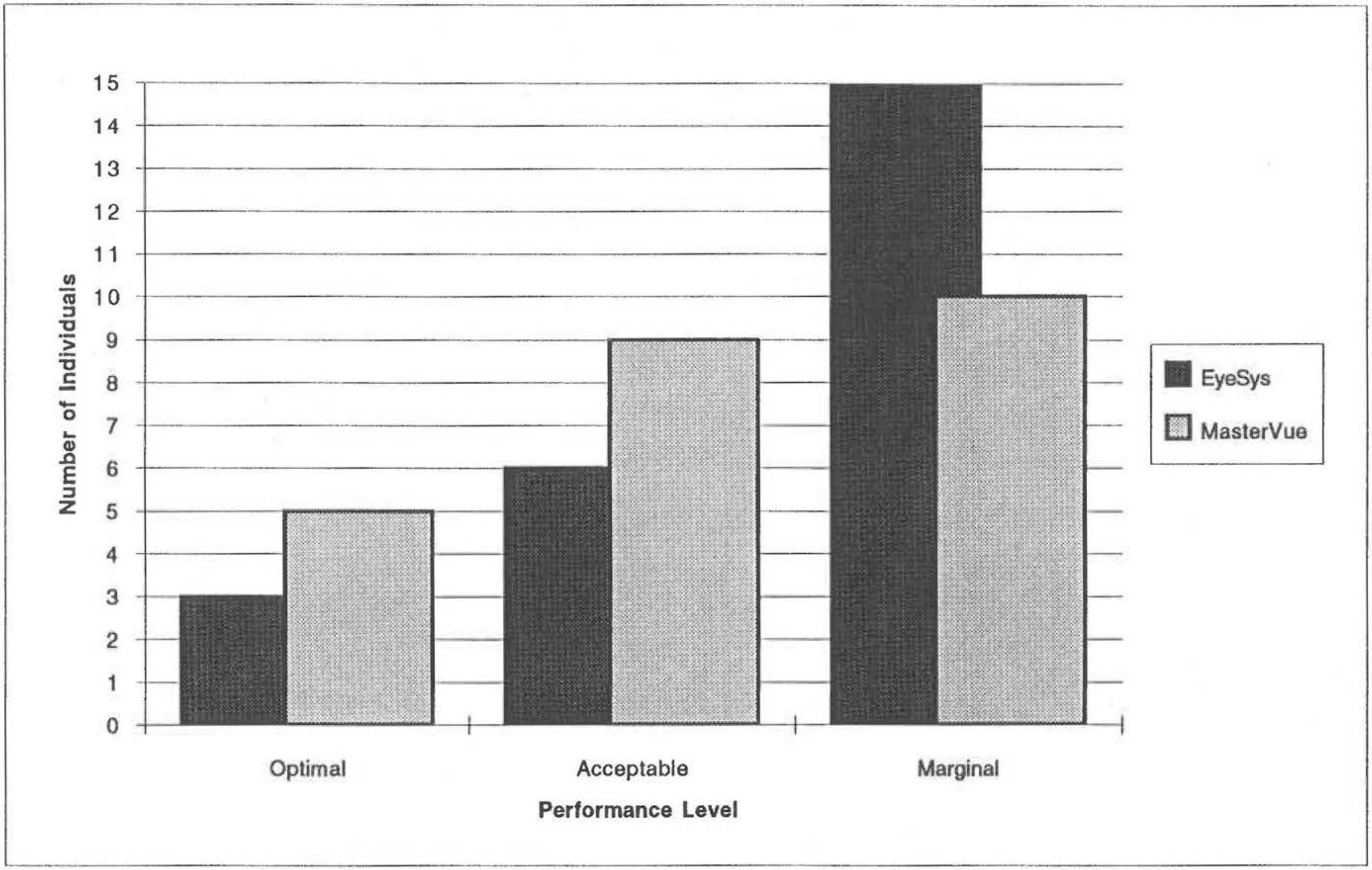
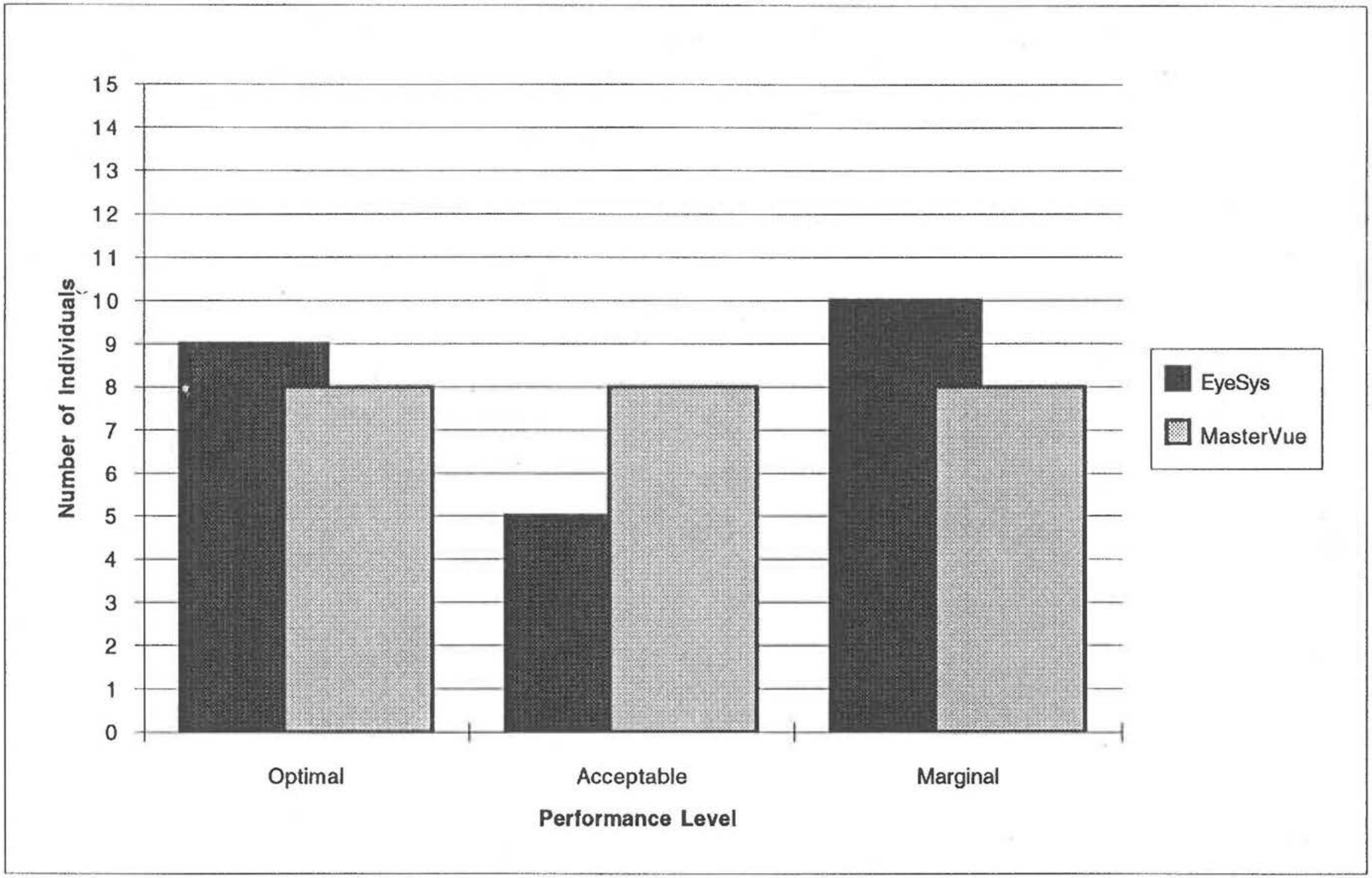


Figure 16. Distribution of Optical Performance Scores.



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Wilcoxon signed-rank X_1: (M) COMFORT Y_1: (E) COMFORT

	Number:	Σ Rank:	Mean Rank:
- Ranks	10	62	6
+ Ranks	1	4	4

note 13 cases eliminated for difference = 0.

Z	-3	p = .0113
Z corrected for ties	-3	p = .008
# tied groups	2	

Wilcoxon signed-rank X_1: (M) VISION Y_1: (E) VISION

	Number:	∑ Rank:	Mean Rank:
- Ranks	9	75	8
+ Ranks	5	30	6

note 10 cases eliminated for difference = 0.

Z	-1	p = .1578
Z corrected for ties	-1	p = .1346
# tied groups	2	

Wilcoxon signed-rank X_1: (M) OR Y_1: (E) OR

	Number:	∑ Rank:	Mean Rank:
- Ranks	10	92	9
+ Ranks	8	78	10

note 6 cases eliminated for difference = 0.

Z	-3E-1	p = .7605
Z corrected for ties	-3E-1	p = .7564
# tied groups	3	

Wilcoxon signed-rank X_1: (M) EP Y_1: (E) EP

	Number:	∑ Rank:	Mean Rank:
- Ranks	7	48	7
+ Ranks	5	30	6

note 12 cases eliminated for difference = 0.

Z	-1	p = .4802
Z corrected for ties	-1	p = .4386
# tied groups	1	

Wilcoxon signed-rank X_1: (M) AP Y_1: (E) AP

	Number:	∑ Rank:	Mean Rank:
- Ranks	5	50	10
+ Ranks	10	70	7

note 9 cases eliminated for difference = 0.

Z	-1	p = .5701
Z corrected for ties	-1	p = .5385
# tied groups	2	

Wilcoxon signed-rank X_1: (M) VA Y_1: (E) VA

	Number:	∑ Rank:	Mean Rank:
- Ranks	6	27	4
+ Ranks	3	18	6

note 15 cases eliminated for difference = 0.

Z	-1	p = .594
Z corrected for ties	-1	p = .5839
# tied groups	2	

Wilcoxon signed-rank X_1: (M) LP Y_1: (E) LP

	Number:	∑ Rank:	Mean Rank:
- Ranks	10	71.5	7.15
+ Ranks	3	19.5	6.5

note 11 cases eliminated for difference = 0.

Z	-1.817	p = .0692
Z corrected for ties	-1.872	p = .0613
# tied groups	2	

One Group Chi-Square X_1: RANDOM Y_1: OBSERVED

DF:	Chi-Square:	Probability:
23	34	.0605