CHANGE IN ACCOMMODATIVE RESPONSE & POSTURE INDUCED BY NEARPOINT PLUS LENSES PER MONOCULAR ESTIMATE METHOD RETINOSCOPY

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Abstract

Monocular Estimate Method Retinoscopy was used twice to measure the accommodative posture of 211 pre-presbyopic subjects. It was first measured with their farpoint lenses in place, and second, with the farpoint lenses and nearpoint plus lens additions (PLA) in place. The PLAs utilized for the second MEM were based on the binocular cross cylinder findings. The findings from the MEM-twice procedure were used to calculate the change in accommodative response that occurred from the plus lenses. The predominant change was a reduction of accommodation by an amount less than the dioptric power of the PLA, and the mean change was negative accommodation equal to 62% of the PLA. This tendency for incomplete negative accommodation to occur in response to a PLA shifted accommodative posture to less lag or more lead for over 3/4 of the subjects. The changes in accommodative response and posture that are revealed by the MEM-twice procedure are consistent with previous studies of how accommodation changes in response to a nearpoint plus lens. The MEM-twice method is a procedure to determine whether a PLA is indicated or contraindicated for the particular patient.

Key Words

accommodation, accommodative posture, accommodative response, binocular cross cylinder, esophoria, Monocular Estimate Method Retinoscopy, nearpoint plus lenses

INTRODUCTION

A nearpoint plus lens addition (PLA) to the farpoint lens can be a form of vision care provided to pre-presbyopic patients. The primary external effect of a PLA is to decrease the accommodative demand of nearpoint targets. It follows that testing to determine if a patient would benefit from a PLA should include tests of accommodation. More specifically, the effect of a PLA on accommodative response (AR) and accommodative posture (AP) could support or contraindicate a PLA, and, help the prescriber select the optimal power of the PLA.

The AR to a nearpoint stimulus is the amount of accommodation activated to obtain identification of the target. It can be less than the demand (lag), equal to (no-lag), or exceed the demand (lead). The manifestation of accommodative response as lag, no-lag, or lead is termed accommodative error[1] or AP.[2] An AP of lag means that the target image is conjugate with a point behind the retina. An AP of lead means that the target image is conjugate with a point in front of the retina and in an AP of no-lag the target and retina are conjugate.

A PLA can influence AR and AP in one of four ways as shown in Figure 1.

- In a Type 1 response, negative accommodation is activated in an amount equal to the dioptric power of the PLA; e.g., a +1.00 add triggers a 1.00D reduction in the AR. In a Type 1 response, AR changes maximally and AP does not change.
- In a Type 2 response, the AR decreases but in an amount less than the add power.
- In a Type 3 response, the AR does not change when the PLA is in place.

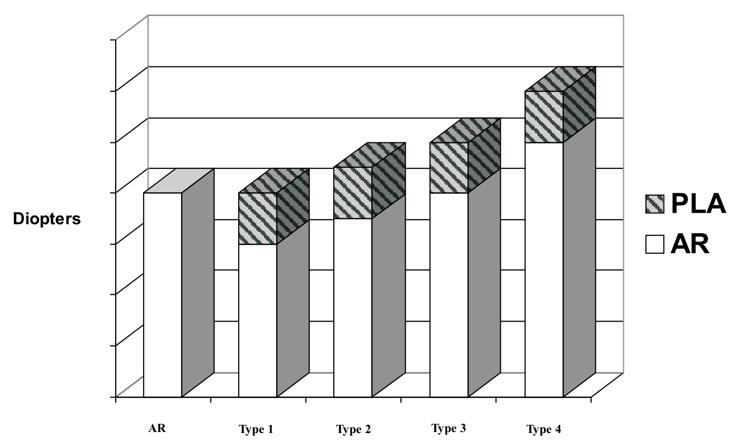

Figure 1. Four types of changes in accommodative response (AR) when a plus lens addition (PLA) is introduced. The extreme left bar is the AR without a PLA.

- In a Type 4 response, there is an increase in AR to a PLA.

For AR changes Type 2, 3, and 4, AP shifts toward less lag/more lead with the PLA in place.

BACKGROUND AND LITERATURE REVIEW

Nearly 60 years ago, Morgan[3] showed that accommodation, as measured by a haploscope, relaxes in response to a PLA by an amount less than the dioptric power of the PLA. This incomplete relaxation of accommodation (Type 2 in Figure 1.) was also the mean response in recent research[1,4] that used a stigmatoscope to determine the change in AR to PLAs. The adult subjects in these two studies showed increasing leads of accommodation with PLAs of increasing power. Another study using an autorefractor found that the monocular AP shifts from lag to lead as the accommodative demand is reduced with incremental increases of plus lens power.[5]

The change in AR to a PLA can be assessed clinically with monocular estimate method (MEM) retinoscopy as described by Haynes[6], May[7], and Birnbaum.[8] MEM is a popular clinical test of AP that is reliable on an inter-examiner basis.[9,10] It is valid based on its very high correlation with haploscopic determination of AR.[11] The procedure for determining the change in AR is to administer MEM twice. It is first administered with the planned farpoint lens prescription in place and second with a PLA in place. The change in accommodation that takes place with the PLA in place can be calculated by comparing the results of the two MEM tests.

Haynes provided an extensive review of the change in AR to a PLA using MEM.[6] He postulated and described seven possible response patterns to PLAs of increasing plus power. The response patterns were case examples drawn from clinical records. One of the seven was the Type 1 response in Figure 1, in which the negative accommodation activated equaled the dioptric power of the lens for PLAs of +0.25DS OU, +0.50DS OU, and +0.75DS OU. Four of the seven response patterns were negative accommodation less than the PLA power and another was no change in accommodation through a range of six different PLAs. The seventh response pattern showed an increase in the AR when certain PLAs were in place. This pattern is a Type 4 response.

As part of a MEM validity study, MEM was administered to four adult subjects with a broad range of minus and plus adds in place.[11] This group showed an AR that shifted from high lag with a minus add in place toward lower lag then lead as the minus add power declined and plus lenses of increasing power were introduced. Another study used MEM at the endpoint of the negative relative accommodation test and found a high accommodative lead (-1.42D +/- .17).[12] This result indicates that the nine pre-presbyopic adult subjects in this study did not relax their accommodation in unity with the plus lenses in place at the endpoint of the NRA test. Two other studies that used nearpoint retinoscopy methods other than MEM showed that the accommodative lag shifted toward less lag/lead with a PLA.[13,14] Thus, accommodation did not relax completely to the PLA.

PLAs are prescribed to pre-presyopic individuals based on a broad range of clinical tests (see Appel,[15] May,[7] May[16] and Goss[17] for a review) and intended patient benefits (see Press[18] for a review). The change in AR to a PLA may weigh heavily in the clinical decision of whether or not to prescribe one. If the goal is to reduce the magnitude of an esophoria through accommodative convergence, then a Type 1 response is desirable, a Type 2 response may be acceptable and a Type 3 or 4 response is undesirable. On the other hand, if the goal is to reduce an abnormally high accommodative lag to zero or near zero, then a Type 1 response is undesirable because the accommodative lag would remain the same (high), with the PLA in place.

While the MEM-twice method of measuring the change in AR to a PLA would appear to be a viable clinical procedure, its application to a clinical population has not been studied extensively. Haynes work consisted of case studies that were presented during a symposium to demonstrate possible AR type patterns based on MEM results.[6] Two other studies used the MEM-twice method on small population samples of four[11] and nine[12] pre-presbyopic adult subjects. Moreover, it was not the expressed purpose of these two studies to evaluate and report on the MEM-twice method.

The present study was initiated to evaluate the results of administering MEM through the indicated farpoint lens prescription and again through a PLA and farpoint lenses as a way to assess the change in AR to a PLA. The population sample was larger than previous studies and it included a broader age range of pre-presbyopic subjects.

SUBJECTS

The subjects (n=211) were drawn consecutively over a six month period. from the author's private optometry practice in a large metropolis. Subjects chosen were at least 6 years old and no more than 37 years old. Individuals were excluded from the study if constant strabismus, amblyopia, or eye disease affecting visual acuity were present. The mean age was 14.5 years (SD, 7.9); median age 11.0 years, and ages ranged from 6.0 to 37 years. Eighty-five of the subjects were between 6 and 10 years old. Eighty-four were 11 to 20 years. and 42 were aged 21 to 37. There were 97 males and 114 females.

This same population sample participated in a previous study of MEM as it relates to refractive status and near heterophoria.[19]

METHOD AND MATERIALS

The author was the sole examiner. Both MEM measures followed basic entrance tests, static distance retinoscopy, subjective refraction, and phorometry. In all cases, the binocular (fused) cross cylinder test (BXCYL) was one of the phorometric tests. It was administered in the manner described by Grovesnor under dim room illumination.[20] MEM preceded diagnostic pharmaceutical agents, tonometry, biomicroscopy and ophthalmoscopy. MEM was administered first with the subjective refraction lenses in place in a trial frame. It was administered a second time with the farpoint lenses combined with the PLA (MEM_{PLA}). The power of the PLA was set equal to the BXCYL if its result was +0.50D or higher. For BXCYL results of +0.25D or less, the PLA was +0.50D. When the MEM tests were administered, the examiner was not masked to the results of the BXCYL test and other visual findings such as heterophoria and subjective refraction. In addition, the second administration of MEM was carried out with full awareness of the results of the first.

MEM was performed under full fluorescent room illumination (45 ft-c) using a model number 18010 Welch Allyn spot retinoscope[a] per the protocol described by

Haynes[6] and Rouse et. al.[21] The target was the appropriate MEM Nearpoint Card[b] clipped to the retinoscope. The card selected was based on the grade level of the patient. The words printed on the MEM Nearpoint Cards above the primer level are 8 point type with one exception. One side of the first grade card is 12 point. Generally, patients in first grade viewed 12-point type while all others viewed 8-point type. With the patient wearing his farpoint lenses in a trial frame, he was handed the MEM card to read. The patient's spontaneous working distance was measured and then used as the test distance for both MEM testings. If a grossly abnormal spontaneous working distance was demonstrated, the Harmon distance (the linear measure from the subject's elbow to his mid- knuckle) was used. MEM was administered to each eye under binocular viewing conditions and the recorded result was the lens that gave a neutral reflex with a quick single sweep of the retinoscope spot.

The second administration (MEM_{PLA}) was with the algebraic sum of the indicated farpoint lenses and the PLA in the trial frame. For example, if the subjective refraction was –0.50 –0.50 X 090 OU with a BXCYL result of +1.00D, MEM was administered through the subjective refraction lenses and then again through +0.50 –0.50 @ 090 OU. The same working distance and target were used for the second administration and the second administration took place immediately after the PLA was incorporated into the trial frame. All MEM results reported in the present study were from the right eye.

The following formula was used to determine the change (Δ) in AR from MEM finding with the farpoint lens in place to the AR with the combination farpoint lenses and PLA in place:

$$\Delta = (MEM - MEM_{PLA}) - PLA$$

MEM = the MEM finding with the farpoint lens in place

PLA = the dioptric value of this convex lens

MEM_{PLA} = the MEM finding with the farpoint and PLA lenses in place

For both the MEM and MEM_{PLA} findings; lag is a positive number, lead is a negative number.

A negative Δ number indicates that negative accommodation resulted from the MEM_{PLA} condition; a positive Δ number indicates that positive accommodation was activated in the MEM_{PLA} condition. See Appendix for examples.

RESULTS

Table 1 shows the mean, median, and mode MEM findings when the subjective refraction lenses were in place. The MEM result ranged from 0.75 lead to 1.75D lag. The distribution of MEM results is shown in Figure 2. For purposes of rating the MEM result as normal, lead or excessive accommodative lag, criteria were used based on the assumption that >1 standard deviation from the mean is undesirable.

Applied strictly, normal would be MEM results in the range of +0.01 to +0.69. This range was modified slightly so that normal was 0.00 to +0.70D. Thus, any accommodative lead or accommodative lag greater than +0.70D are not in the normal range. Table 1 shows the distribution of MEM after each result was classified as lead, normal, or excessive lag. These results were reported previously in a study of MEM central tendency measures.[19]

The distribution and mean of PLAs used are shown in Table 2. It shows that the predominant PLA used was +0.75.

Table 1. Central tendency measures and distribution of AP

	MEM[A]	MEM PLA[B]
Mean (+/- SD)	+0.35 (.34)	+0.04 (.35)
Median	+0.25	0.00
Lead[C]	6% (12)	28% (58)
Normal[D]	77% (163)	68% (144)
Lag[E]	17% (36)	4% (9)

A = MEM, right eye.
B = MEM_{PLA}, right eye.
C = Lead MEM or MEM_{PLA} <0.00 (a negative #)
D = Normal MEM or MEM_{PLA} 0.00 to +0.70
E = Excessive lag MEM or MEM_{PLA} >.0.70

Table 2. PLAs used for MEM_{PLA}

PLA	Number (Percentage)	Mean PLA (s.d.)
+0.50 DS OU	23 (11)	
+0.75 DS OU	121 (57)	
+1.00 DS OU	57 (27)	+0.82 DS OU (+/- .20)
+1.25 DS OU	5 (2.5)	
+1.50 DS OU	5 (2.5)	

PLA – Plus Lens Addition
MEM_{PLA} - Monocular Estimate Method retinoscopy administered with PLA in place.

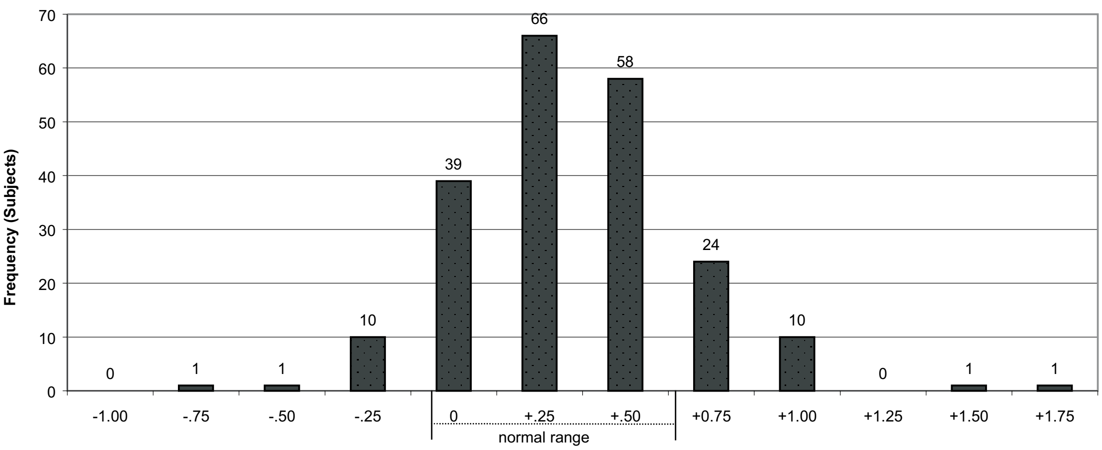

Figure 2. Histogram showing the frequency distribution of MEM values for the right eye of all subjects. (N=211)

The mean and median AP for the MEM_{PLA} condition was essentially no-lag as shown in Table 1. The MEM_{PLA} ranged from a lead of –1.25 to a lag of +.75D and was distributed as shown in Figure 3.

The MEM-twice formula for calculating the change in AR was applied to the findings. The distribution and mean of the formula results are shown in Table 3.

The mean change, 0.51D negative accommodation, expressed as a percentage of the mean PLA, +0.82D, was 62% of the PLA. Fifty, or 24%, of the subjects re-

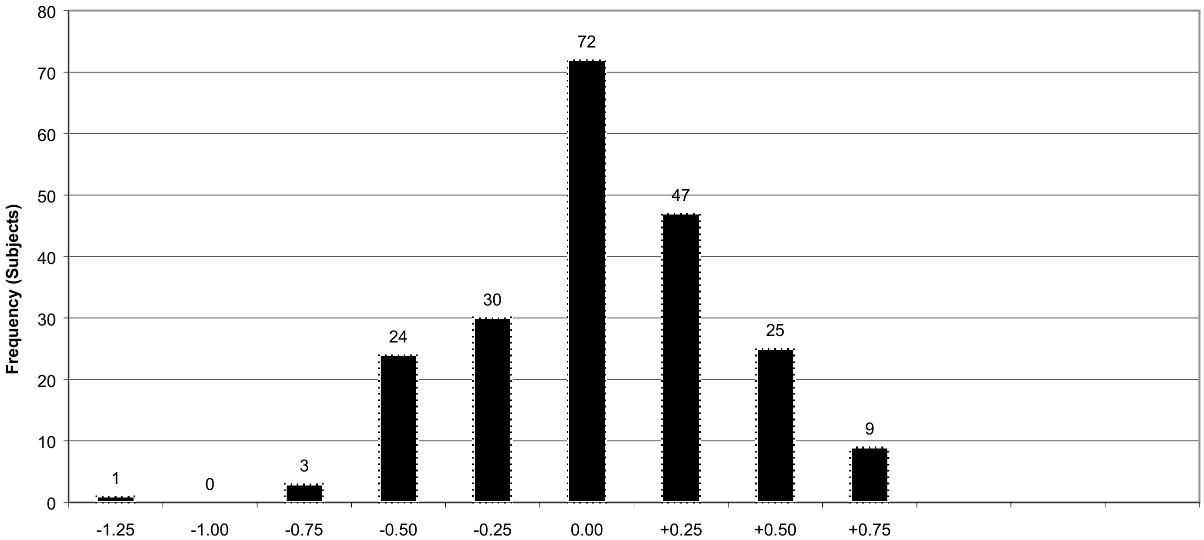

Figure 3. Frequency distribution of MEM_{PLA} results, right eye.

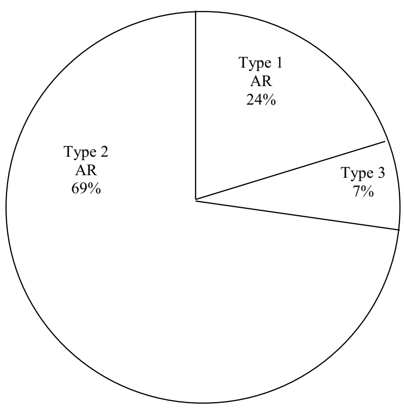

Figure 4. Distribution of AR changes with PLA in place.
Type 1 – Negative accommodation equal to PLA. (n = 50)
Type 2 – Negative accommodation less than PLA. (n = 146)
Type 3 - No change in accommodative response. (n = 15)
Type 4 – Increased accommodation (n = 0)

duced their accommodation by an amount equal to their PLA and were classified as Type 1 response as shown in Figure 4. Figure 4 shows that the majority of the group showed Type 2 (incomplete negative accommodation). A small percentage had no change in their AR (Type 3) while their AP shifted toward lead (less lag) by an amount equal to the PLA. There were no subjects who increased their AR under the MEM_{PLA} condition, nor were there subjects whose negative accommodation exceeded the power of the PLA.

The effect of the PLA on the classification of AP as lead, normal lag, or excessive lag is shown in Table 4. Among the twelve subjects with accommodative lead, all remained lead with the PLA in place with nine (75%) shifting to greater lead. Seventy-three percent of subjects with an AP in the normal range without a PLA remained in the normal range with a PLA in place with the remainder of the normal APs shifting to lead with the PLA in place. The change in AP classification with the PLA in place is also reported for the group of 36 subjects with excessive accommodative lag per MEM.

Table 5 provides a closer look at the AP of no lag (MEM or MEM_{PLA} = 0.00). Among the 39 subjects who had an MEM of no lag, 13 retained their no lag status with the PLA in place while 26 shifted to lead. There were 160 subjects whose MEM was +0.25 lag or higher and 59 became no lag with the PLA in place.

DISCUSSION

The MEM-twice procedure shows that the predominant change in AR through a BXCYL based PLA is negative accommodation by an amount less than the PLA. This result from a consecutively presenting clinical sample is consistent with previous investigations of AR change to a PLA.[1,3-5,11-14] Approximately 2/3 of the subjects showed a Type 2 response while 1/4 of the subjects had an AR change that equaled the dioptric power of the PLA (Type 1) and, by definition, had no change in their AP with the PLA in place. A small minority of subjects, 7%, did not change their AR (Type 3) even though the accommodative demand had changed because of the PLA. The change in AR was calculated with an original equation from the results of a brief, clinician-friendly test – MEM retinoscopy.

Rosenfield and Carrel used a stigmatoscope and found that the predicted PLA to give an AP of no-lag is +0.78 if AP is 0.30D lag without the PLA.[1] In this instance, no-lag occurs because the +0.78 add compensates for the 0.30D lag, and accommodation decreases by 0.48D. Expressed as a percentage of the PLA, 0.48D is 62% of the PLA.

The results of the present study are strikingly close to the Rosenfeld and Carrel study. The present study sample had a mean AP of +0.35 lag that changed to a mean of +0.04 with a mean PLA of +0.82. The mean change of 0.51D is 62% of the +0.82 PLA. These coincidental findings strongly indicate that the MEM-twice procedure can provide accurate information about the change in AR to a PLA that heretofore came from laboratory instruments such as haploscopes,[3,11] stigmatoscopes,[1,4] and infrared optometers.[5] A study that compares the MEM-twice method to an objective measure of AR such as an infrared optometer would support or reject this clinical finding.

Haynes published the seminal study on the MEM-twice procedure.[6] The present study found three of the four response types Haynes postulated. It did not find any subjects who *increased* accommodation with a PLA in place, as did the Haynes study. Perhaps a larger sample would find

TABLE 3.
Calculated change in AR with PLA in place using MEM Twice Formula

Accommodative Response Change	PLA +0.50	+0.75	+1.00	+1.25	+1.50	Total
Increased accommodation	-	-	-	-	-	0
No decrease	9	5	1	-	-	15 (7.1%)
0.25 decrease	3	40	3	1	-	47 (22.3%)
0.50 decrease	**11**	47	17	-	1	76 (36.0%)
0.75 decrease	-	**29**	27	2	2	60 (28.4%)
1.00D decrease	-	-	**9**	1	2	12 (5.7%)
1.25D decrease	-	-	-	**1**	1	1 (0.5%)
Mean decrease = 0.51 (+/-.26)						211 100%

***Bold**, subjects whose decrease equaled the PLA (a Type I response).*

Table 4.
Change in AP with the PLA in place.

MEM with PLA in place	MEM with subjective refraction lenses in place. Lead MEM ≤ -.25 (n = 12)	Normal 0.00 ≤ MEM ≤ 0.50 (n = 163)	Excessive Lag MEM > +.75 (n = 36)
Equal to MEM with SR lenses in place	3 (25%)	43 (26%)	4 (11%)
Lag decreases, MEM_{PLA} is normal	0	76 (47%)	25 (69%)
Lag decreases, MEM_{PLA} is excessive lag	0	0	5 (14%)
Lag decreases/ lead increases MEM_{PLA} is lead	9 (75%)	44 (27%)	2 (6%)

Table 5.
Impact of PLA on the AP of no lag (MEM or MEM_{PLA} = 0.00)

MEM	MEM_{PLA} Remains > 0.00	Equal to 0.00	Lead
Lag > 0.00 (n = 160)	81	59	20
No Lag (n = 39)	0	13	26
Lead (n = 12)	0	0	12

this type of response. Haynes record review study found a single subject with this type of response "after a good deal of searching".[6]

The results of this study may be useful in the system clinicians use to prescribe a PLA to their pre-presbyopic patients. If a PLA is under consideration because excessive accommodative lag is present, the BXCYL is a good first choice lens. As shown, 69% of the present study's subjects with excessive accommodative lag gained an AP in the normal range with the BXCYL based PLA in place. The remainder whose AP remained abnormal with the PLA in place is not insignificant. A clinical strategy could be to place the BXCYL PLA in a trial frame, administer MEM and, if MEM_{PLA} is abnormal, adjust the PLA up or down accordingly and repeat MEM with the adjusted PLA in place.

Another common condition for which a PLA is a treatment option is esophoria. Goss recommended that the dioptric power of the PLA be set high enough so that the esophoria is eliminated and the phoria measurement shows orthophoria or low exophoria.[17] One possible drawback to this method is that the PLA, while ameliorating the esophoria, could induce an abnormal AP lead, where there was not a lead without the PLA. The data in Table 4 suggests that 33 % (27% plus 6%) of pre-presbyopic individuals with an AP of 0.00 or greater will shift to a lead of accommodation with a PLA in place. Therefore, it may be helpful if the MEM is repeated with the PLA in place along with a repeat of the phoria measurement.

The use of a PLA to slow the progression of myopia is a past and ongoing research and clinical topic of great interest. The theoretical mechanism by which a PLA may slow myopia progression is usually related to accommodation, specifically a lessening of AR.[22] This study demonstrates, however, that 7 % of pre-presbyopes do not lessen their accommodation with a PLA in place and another 22 % activated only .25D of negative accommodation – perhaps an insignificant amount. This result raises the possibility that some individuals receiving a PLA for myopia control do *not* alter their accommodation or only minimally so, and, the MEM-twice method can be used to test for non-responders.

Another theory relates myopic progression specifically to an accommodative lag.[23,24] In this theory, the lag triggers axial elongation/increased myopia as does induced hyperopic defocus of the retinal image in animals. A PLA that eliminates the lag could inhibit the defocus trigger. This study showed that among the 160 subjects with a lag of +0.25D or higher, 59 (37%) became no lag (MEM_{PLA} = 0.00) with the BXCYL based PLA in place. For the other 101 lag subjects, the BXCYL PLA was insufficient plus to eliminate the lag completely in 81 of them ($MEM_{PLA} \geq$ +0.25). It was too much plus for 20 of them because the MEM_{PLA} was lead. There were 39 subjects in this study with a no-lag AP through their subjective refraction lenses, and 2/3 of this group lost their no-lag status, becoming lead, with the BXCYL based PLA in place. On a clinical basis, MEM-twice could become MEM-three (or four) times to determine the PLA that yields an AP of no-lag if that is the desired outcome. MEM-twice would also show that a no-lag AP is not possible with a PLA if lead is present with all PLAs tested.

Another possible trigger for a prescription PLA is accommodative lead. At first blush, the clinical dictum "plus lenses relax accommodation" would support this approach. Using the MEM-twice formula, the only way a lead can change to less lead is for negative accommodation to take place that is greater than the PLA.

For example, a patient with a –0.50 lead would have to activate 1.00D of negative accommodation with a +0.50D PLA in place to achieve a no-lag AP. Birnbaum stated that a lead found with MEM sometimes relaxes with a PLA but, "…more frequently, accommodation does not relax through plus and MEM shows increased against motion suggesting that plus lenses are unlikely to be accepted".[8] In the present study, none of the 12 subjects with a lead had a reduction of the lead, and nine of the 12 showed the increased against motion that Birnbaum described. Perhaps a better, albeit more cumbersome, clinical dictum is "Plus lenses reduce the accommodative demand. In response, the individual may or may not decrease her accommodation, and, she or he will never do so by an amount greater than the PLA so that a lead shifts toward lag." Or, "plus lenses do not relax accommodation, people do."

An accommodative lead is a visual status that is uncommon and viewed as a significant visual abnormality. This study and a previous one[21] found that accommodative lead is present in 5 to 10% of subjects. In the Skeffington case analysis method, an accommodative lead, sometimes called minus projection or minus-at-near, is thought to result from a visual system that has deteriorated significantly from nearpoint stress.[25] This study shows that a PLA based on the BXCYL result can induce a lead in a patient who has a lag without a PLA. There were 46 (22%) subjects in this study who shifted to a lead of accommodation with the PLA in place, but did not have one with the subjective refraction lenses in place. Birnbaum stated that plus lenses that induce a lead of accommodation are "… likely to interfere with usual function."[8] If plus lenses induce a lead, the power can be reduced until a normal AP is present, or, the clinician may forgo PLA as a treatment option.

There is an unanswered question regarding the AP that is measured by MEM when a PLA is in place. Does it change over time? This study did not address that question. Another limitation of this study is that the same examiner gave both MEM tests, which introduces the possibility of examiner bias. This study is also limited by the utilization of a single add power - the BXCYL result. From a clinical standpoint, if the BXCYL lens produces an undesirable AP, other PLAs could be applied and MEM repeated again. This study did not take into account other tests that could support the prescription of a PLA. The performance test battery described by Apell[15] (including pursuit eye movements, Bell retinoscopy, ball catch and throw) and other open space tests such as the Macdonald Form Recognition card and stresspoint retinoscopy (described by May[7,16]) could be utilized. The MEM-twice procedure could be used as one test among several in the ultimate determination of prescribing a PLA and its amount. A useful line or research would be to investigate which test or tests are the best predictor of a successful PLA.

Another limitation of this study is the lack of a measure of change in AR independent of MEM. A previous study showed that MEM is about equal to haploscopic measurements of AR through a broad range of plus (and minus) adds.[11] Nonetheless, the results of the present study would be more convincing if the AR and AP changes yielded by the MEM-twice procedure were confirmed by a haploscope or infrared optometer.

CONCLUSION

The MEM-twice procedure administered to a large clinical sample shows that most pre-presbyopic subjects reduce their AR to a PLA by an amount less than the dioptric amount of the PLA. This incomplete negative accommodation shifts the AP toward less lag/ increased lead. The change in AR was calculated with an original equation called the MEM-twice formula. It shows that, on average, pre-presbyopic subjects reduce their AR by approximately 60% of the dioptric power of the PLA when a PLA in the neighborhood of +0.75 is used.

The AR changes revealed by the MEM-twice procedure are consistent with what would be expected according to previous clinical and laboratory research that used different methods. This consistency supports the continued use of MEM to aid the clinician in determining if a pre-presbyopic requires a PLA and in what amount.

The PLAs used in this study were based on the BXCYL test and they were helpful in reducing an abnormally high lag to a normal AP for most high lag subjects. BXCYL based PLAs did not improve the AP in any of the accommodative lead subjects and, in fact, worsened the lead in most of them. Subjects with an AP in the normal range per MEM had mixed results with the BXCYL based PLA in place. Most retained their normal AP status but a noteworthy number of them, 27%, shifted to a lead of accommodation. The less than optimal improvement in AP in many of the subjects means that the MEM-twice procedure may require extension to a third or fourth MEM with different PLAs if the first MEM_{PLA} does not yield the desired AP.

ACKNOWLEDGEMENTS

Paul DeLand Ph.D provided the statistical analysis of the study results. Dr. Michael Rouse and the late Dr. Marty Birnbaum provided the inspiration for this study and helpful guidance in writing the manuscript.

The author has no financial or other interests in any of the products utilized in this study.

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Date accepted for publication:
April 22, 2005

APPENDIX

Δ = (MEM–MEM_{PLA})–PLA

1. A patient views text at a distance of 33cm. In response to this accommodative demand of 3.00 diopters (D), the patient activates 2.50D of accommodation. The MEM finding is a 0.50 lag. With a +0.75 PLA in place, the accommodative demand drops to 2.25D and the patient activates 1.75D of accommodation to assume the same AP. The MEM_{PLA} finding is 0.50lag.
   The formula shows:
   Δ = (+0.50 - +0.50) – (+0.75) = (0) – 0.75 = -0.75D negative or relaxation of accommodation
   This illustration is a Type 1 response in which accommodation diminishes by an amount equal to the PLA. A +0.75 PLA brought about 0.75D of negative accommodation. This response type leads to a quick calculation because the MEM result with the farpoint lens is identical to the MEM result witht the PLA in place.
2. A patient views text at 33cm. He activates 2.75D of accommodation resulting in a MEM finding of 0.25 lag. With a 0.75 PLA in place, 2.50D of accommodation is activated in response to the now 2.25D demand. This results in a MEM_{PLA} finding of 0.25 lead.
   This shows:
   D = (+0.25 - -0.25) – (+0.75) = +0.50 – 0.75 = -0.25D negative accommodation.
   This example is a Type 2 reponse.