A STUDY OF THE RELATIONSHIP BETWEEN A DYNAMIC RETINOSCOPIC AND DYNAMIC COVER TEST TECHNIQUE

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INTRODUCTION

Patients with asthenopic symptoms secondary to accommodative and or vergence anomolies routinely present for treatment. The relative frequency of presentation has prompted the development of numerous techniques to assess the static and dynamic health of accommodative and vergence systems.

The techniques have been both static and dynamic in their approach. Traditionally, static testing is performed with the visual system (eg. accommodation) in a relaxed state. Far point retinoscopy for determining distance refractive error and objective cover test at optical infinity for the accompanying vergence are two examples. Dynamic testing is performed with the visual system in a state of flux such as in the evaluation of the accommodative response to a stimulus at 40 cm. Techniques like Nott (1), Cross (2), Book (3,4), and MEM (5,6) retinoscopy are designed to assess the accommodative response as measured in diopters of accommodative lag.

A liberty is being taken here to expand the definition of dynamic testing to include evaluation of the visual system in a state of flux over a range of distances. This is an important distinction because the visual system is not designed to operate at optical infinity and 40 cm. alone, but at all points from optical infinity to a point less than 40 cm. Depending on the health of a visual system it may react differently at different points and thus manifest itself in differing symptomatology.

There are presently two techniques that can be used over a range of distances. They are Bell retinoscopy (7,8) and the Kinetic cover test (KCT) (9). They have the advantage over other dynamic techniques in that a multitude of points are tested in a relative short time, and the quality and quantity of response to a variable accommodative and vergence demand can be assessed.

To restate the importance of this type of testing, one must remember that the visual system operates under a continuous change in demand which must be adequately compensated for by the accommodative and vergence systems. If adequate compensation is not attained, visual discomfort will result. Therefore, techniques that simulate changing demands should be used because such are the conditions under which the visual system operates.

It has been suggested that Bell Retinoscopy and KCT must both be performed to adequately assess the accommodative and vergence systems. In Bell retinoscopy, the accommodative system response is evaluated by judging the accommodative light reflex. In the KCT, the vergence system is evaluated by judging the phoric posture.

The relationship between accommodation and vergence systems has been well documented both neurologically (10, 11) and clinically(12). Their clinical relationship can best be described via the accommodation-convergence to accommodation ratio(AC/A ratio). The AC/A ratio can be divided into two types: response AC/A and stimulus AC/A. The response AC/A is measured by comparing the change in vergence response to the change in accommodative response for a given change in accommodative stimulus. The stimulus AC/A is measured by comparing the change in vergence response directly to a given change in accommodative stimulus. Obviously, the stimulus AC/A is more variable because it is subject to all the variable influences to which the response AC/A is prone and inhances its own variation with regard to the accommodative response.

From the above discussion it would appear that the findings from

Bell retinoscopy and the KCT may actually reveal similar information about the response of a subject's visual system because the portions of the visual system that they probe are related via the AC/A ratio.

QUESTION:

Is there a direct relationship between the alternating cover test and retinoscopy when a movable accommodative target is used over a range of near distances?

METHOD : PROCEDURE

The following description of retinoscopy and the alternating cover test will not agree with the more traditional dynamic techniques. Modification of the techniques are necessary to eliminate unnecessary bias.

Retinoscopy was performed at a distance of 40 cm. An accommodative target comprised of six lines of letters of Snellen acuity 20/80 to 20/15 was used. The target was attached to a slide on a near point rod and the subject was instructed to hold the end of the near point rod to the center of their chin and begin slowly reading aloud the letters on the top line of the target from left to right. When at the end of the line the subject was instructed to read the next lower line and so on. As the subject read the letters, the target was moved along the midline at eye level from 40 cm to 10 cm from their chin and back out to 40 cm at a rate of 5 cm per second. Markers were placed on the near point rod such that changes in accommodative light reflex could be made to $\pm$ 0.5 cm. Two points were noted. The first was when with-motion was no longer noted and against-motion had not begun. The second was when against-motion was no longer noted and with-motion had not begun.

The alternating cover test was begun at 40 cm. The same Snellen acuity accommodative target was used. As before, the subject was instructed to to slowly read aloud the letters on the top line from left to right, go to the next line below, and so on. The target was moved from 40 cm to 10 cm along the midline at eye level and back out to 40 cm at a rate of 5 cm per second. As the subject read the letters, the eyes were alternately occuluded once per second. The phoric posture was subjectively evaluated as to direction and magnitude at the beginning and end of the test.

An AC/A ratio was determined in the following manner. The subject's spectacle correction for best visual acuity at distance was dialed into an AO Ultramatic Phoropter. A Snellen 20/20 block of letters was placed on a near point rod connected to the phoropter at a distance of 40 cm. Risley prisms were placed 12 base in before the right eye and 6 base down before the left eye. The subject was instructed to fixate and keep as clear as possible the upper block of letters, then to indicate when the two blocks of letters were aligned vertically. The amount of base in and base out prism needed to align the blocks of letters was noted. The identical procedure was followed with +1.00DS over distance prescription and then -1.00DS over distance prescription. From this procedure a gradient AC/A was obtained.

METHOD : SUBJECTS

Thirty-two (32) subjects were chosen from a random primary care clinic population and senior optometric students. Full optometric exams had been performed on all subjects prior to the study. Only those subjects were chosen who did not have a significant accommodative, binocular, pathological, or other ocular dysfunction. Subjects ranged in age from 17 to 34 years old. Seven (7) additional subjects were chosen from a random primary care clinic population in which full optometric exams had been performed. These subjects all had significant accommodative and or convergence dysfunction and were appropriately symptomatic. Their ages ranged from 7-29 years old.

ANALYSIS:

Retinoscopy results were measured in centimeters of accommodative lag. The centimeters of lag were converted to diopters of lag and referenced to the retinoscope positioned at 40 cm(2.50). Initial and final lags were calculated.

Pearson r correlation coefficients were performed on the resultant data as follows: Change in phoria to change in lag for all subjects; change in phoria to change in lag for all symptomatic subjects; change in phoria to change in lag for all subjects with an AC/A ratio of $\leq 2.5/1$ or $\geq 6/1$. A 95% confidence level was thought appropriate.

RESULTS:

For all 39 subjects, the correlation coefficient was 0.07. For the seven symptomatic subjects, the correlation coefficient was 0.39. For the seven subjects with the high or low AC/A ratio, the correlation coefficient was o.70. Only one subject was symptomatic and fit into the high-low AC/A ratio catagory. Table 1 lists all raw data. Graphs 1,2, and 3 give a pictorial view of the data.

DISCUSSION:

The initial impression from the above results is that no correlation exists between the two methods of dynamic binocular assessment. A closer inspection reveals a significant correlation between the two methods in those subjects with binocular dysfunction and those at risk for binocular dysfunction.

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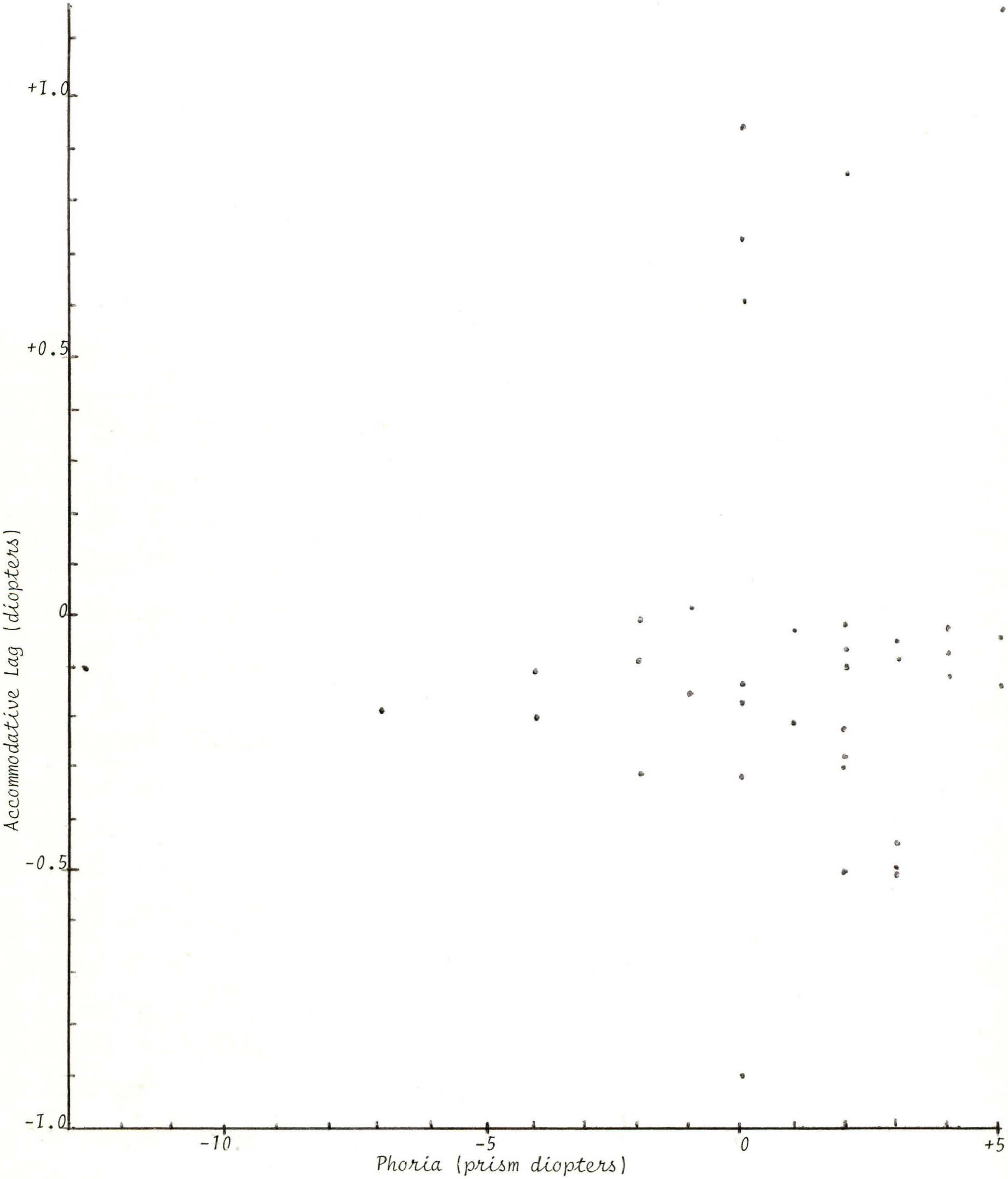
TABLE: 1

Raw Data

Subj.	AC/A	Phoria I	Lag I	Phoria F	Lag F	Δ Phoria	Δ Lag
1	4/1	8ESO	.10	6ESO	.09	-2	-.01
2	3/1	2ESO	.21	Ø	.12	-2	-.09
3	4/1	8EXO	.63	5EXO	.52	-13	-.11
4	3/1	Ø	.21	2ESO	.12	-2	-.09
##5	2/1	5EXO	.37	3EXO	.27	+2	-.10
6	3/1	2EXO	.29	2ESO	.27	+4	-.02
7	3/1	2EXO	.52	2ESO	.21	+4	-.31
8	3/1	2EXO	1.22	1EXO	1.19	+1	-.03
9	4/1	5EXO	.96	Ø	.82	+5	-.14
10	3/1	Ø	.54	3ESO	.06	+3	-.48
11	5/1	Ø	.14	4ESO	.12	+4	-.02
12	3/1	2ESO	.21	5ESO	.12	+3	-.09
13	5/1	Ø	.54	2ESO	.52	+2	-.02
14	4/1	2EXO	.51	Ø	.23	+2	-.28
15	4/1	Ø	.25	2ESO	.19	+2	-.06
16	5/1	3ESO	.37	3ESO	.23	0	-.14
17	3/1	3EXO	.42	Ø	.29	+4	-.13
18	4/1	Ø	.19	4ESO	.12	+4	-.07
##19	2/1	2EXO	.20	6EXO	.09	-4	-.11
*20	3.5/1	Ø	.49	1EXO	.34	-1	-.15
21	4/1	Ø	.14	3ESO	.09	+3	-.05
22	3/1	Ø	.24	1ESO	.05	+1	-.21
23	3.5/1	3EXO	.48	1EXO	1.33	+2	+.85
24	3/1	6EXO	.63	3EXO	.19	+3	-.44
##25	6/1	6EXO	.20	6EXO	.02	0	-.18
*26	4/1	2ESO	-0.14	2ESO	.47	0	+.61
##*27	6/1	1ESO	.49	6ESO	1.64	+5	+1.15
28	4/1	Ø	-0.07	Ø	.87	0	+.94
##29	6/1	Ø	.09	Ø	.82	0	+.73
30	4/1	Ø	1.37	Ø	.47	0	-.90
31	4/1	Ø	.49	2EP	-.01	+2	-.50
##32	2.5/1	2EXO	.54	6EXO	.34	-4	-.20
33	4/1	3EXO	.84	3EXO	.52	0	-.32
34	4/1	2EXO	.79	Ø	.57	+2	-.22
*35	5/1	2ESO	.54	5ESO	.05	+3	-.49
*36	4/1	Ø	.10	2EXO	-.21	-2	-.31
*37	3/1	2EXO	-.07	3ESO	-.10	+5	-.03
*38	4.5/1	2ESO	.20	5EXO	+.01	-7	-.19
##39	6/1	Ø	-.25	1EXO	-.24	-1	+.01

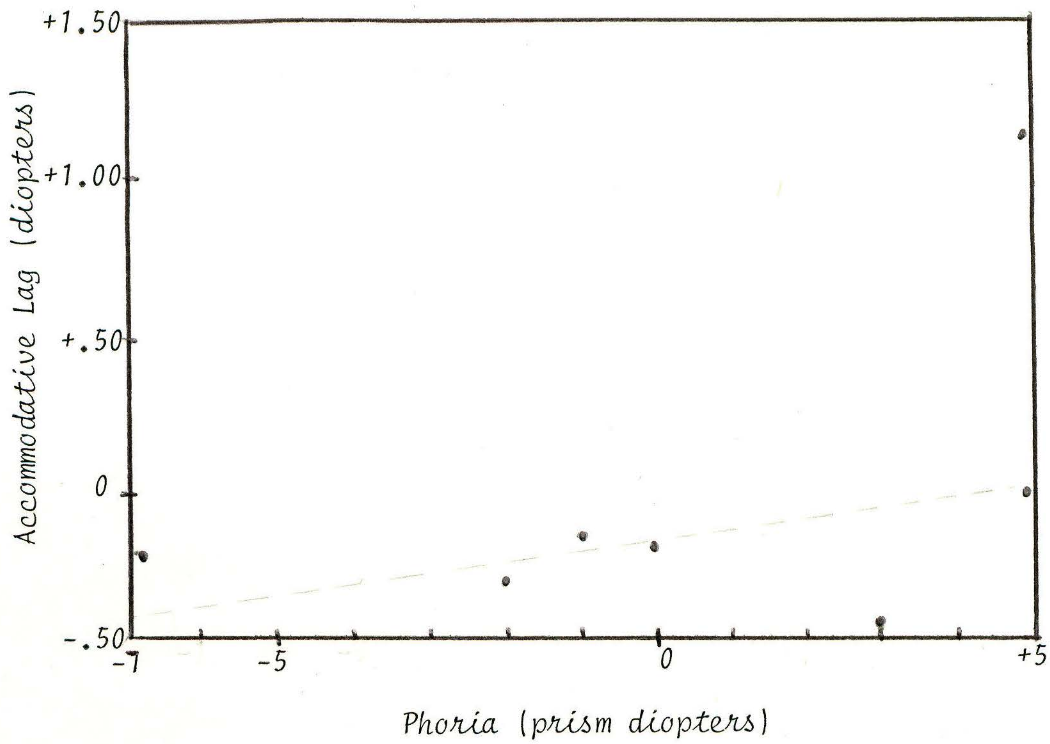
* Symptomatic Subjects

\# Subjects with high or low AC/A ratio



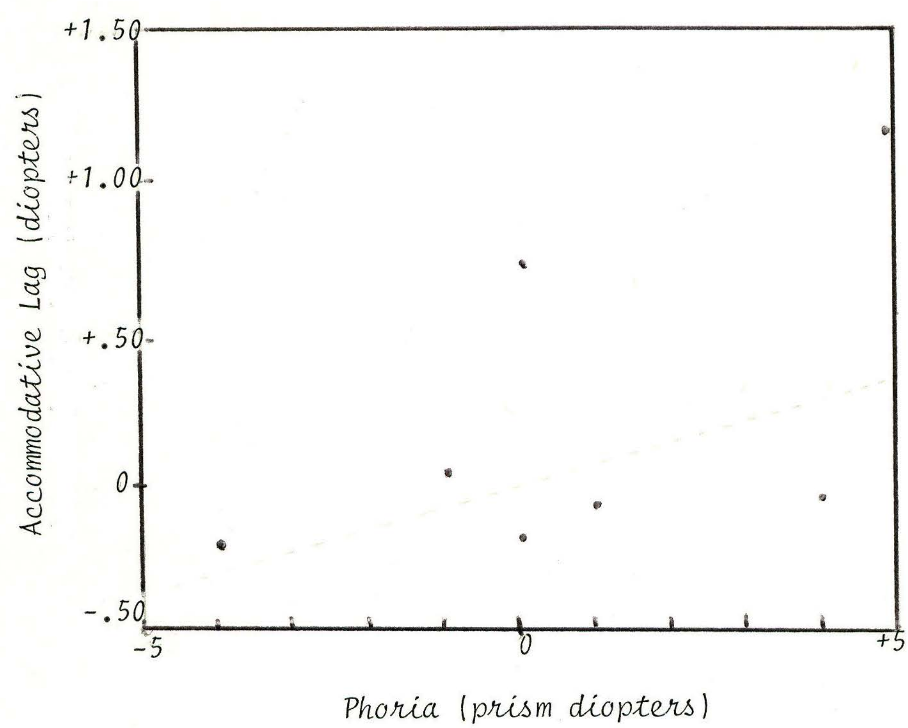
SCATTER GRAPH 1

Δ Phoria vs Δ Lag (all subjects)



SCATTER GRAPH 2

Δ Phoria vs Δ Lag (for symptomatic subjects)



SCATTER GRAPH 3

Δ Phoria vs Δ Lag (for high or low AC/A subjects) testing methods studied do not correlate in the general population of subjects studied. First, the sample was not large enough to get full distribution of non-symptomatic subjects. The results suggest that if a larger number of subjects with higher and lower AC/A ratios could have been included a better correlation would have resulted. Second, subjects within accepted normal ranges with regard to phoria posture, accommodative posture, and AC/A ratio have more ways to compensate subtle dysfunctions in their system. Thus, subjects with similar fusion and accommodative ability may present in enough of a dissimilar manner as to cause inconsistant data. It may be only in those cases when the number of ways for compensation is limited that a consistancey of measurement can be elicited. Third, there were procedural difficulties noted during the administration of the testing. The accommodative demand may not have been sufficiently high in the beginning of the alternating cover test or retinoscopy. The first two lines of the accommodative target equalled 20/80 and 20/60 Snellen acuity. The 20/50 lines would have been a better starting point. The other difficulty encountered was the judgment of the phoria through multiple trial lenses. Many of the subjects were initially uncorrected or need slight adjustments to obtain maximum visual acuity.

An observation was made during the study with regard to the subjects that had binocular dysfunction and those at high risk. When retinoscopy was performed at 40 cm a majority of the subjects would quickly lock on to the accommodative target and would not release from the target until it was beyond the plane of the retinoscope at 40 cm. When the procedure was again performed at 50 cm a more normal response was ellicited in that release from the target occurred prior to reaching the plane of the retinoscope.

One possible explanation is that the accommodative target was more closely approaching the point of dark focus(13). This may be significant because as that point is approached greater amounts of sympathetic innervation come into play which will enhance the release of the accommodative system. The question could now be raised as to whether a test distance of 40 or 50 cm is more likely to ellicit a response indicating a binocular problem.

Two other questions were raised by this study. One: Which is more critical to obtaining valid results when testing the dynamic visual system, the actual accommodative demand or amount of visual attention? Two: What factors lead to binocular dysfunction symptomatology in one subject and not the other given equal visual demands and skills?

SUMMARY:

This study indicates a direct correlation exists between the alternating cover test and retinoscopy when an accommodative target is moved through a range of near distances. Correlation between the two techniques suggests that only one of them needs to be performed to identify subjects with or are at risk for binocular dysfunction. The other conclusion to be drawn is that one of these techniques should be included as a portion of a full and complete optometric examination.

Several questions were raised by this study. One: Will a change in the test distance of a given retinoscopic technique effect the chances of detecting a binocular dysfunction? Two: Is the visual demand or visual attention a more critical factor in obtaining valid test results in accommodative testing? Three: What factors cause some subjects to manifest binocular dysfunction symptomatology when in other subjects with similar visual skills and demands do not manifest symptoms?

REFERENCES

1. Borish, I.M., Clinical Refraction, Chicago, Illinois: Professional Press, 1979, 697-698.

2. Borish, I.M., Clinical Refraction, Chicago, Illinois: Professional Press, 1979, 698.

3. Pfeiffer, C.H., "Book Retinoscopy". American Journal of Optometry and Archives of the American Academy of Optometry, October 1955, 540-545.

4. MacDonald, L.W., "A Therory for Interpreting Book Retinoscopy Observations". Optometric Weekly, July 19, 1962, 1446-1447.

5. Haynes, H.M., " Clinical Observations With Dynamic Retinoscopy". Optometric Weekly, October 27, 1960, 2243-2246; November 3, 2306-2309.

6. McKee, G.W., "Reliability of MEM Retinoscopy". Optometric Monthly December 1981, 30-31.

7. Pomeranz, R.B., "The Use of Bell Retinoscopy to Determine Near Point Prescription". Optical Journal and Review of Optometry, December 1964, 21-24.

8. Apell, R.J., "Clinical Application of Bell Retinoscopy". Journal of the American Optometric Association, October 1975, 1023-1027.

9. Griffin, J.R., Binocular Anomalies, Procedures for Vision Therapy, Chicago, Illinois: Professional Press, 1976, 142-143.

10. VonNoorden, G.K., Binocular Vision and Ocular Motility, St. Louis, Missouri: C.V. Mosby Company, 1980, 119-128.

11. Burde, R.M., Adler's Physiology of the Eye Clinical Application, St. Louis, Missouri: C.V. Mosby Company, 1975, 148-150.

12. Grosvenor, T., "AC/A in Prescribing", Optometric Weekly, Aug. 14, 1975, 16-18.

13. Borish, I.M., Clinical Refraction, Chicago, Illinois: Professional Press, 1979, 103-109.

Introduction

It is assumed by many that accommodative responses in children are consistent and accurate. Extensive research has been done investigating the properties of accommodation in adults with the results also attributed to children. Clinical models of accommodative and convergence functioning (1) based on adult performances have been commonly applied to children. With a child,because of attentional or perhaps ~~experimental~~ experiental factors, there are no assurances that accommodative responses are consistent or that accommodative responses always equal stimulus demands. This becomes particularly apparent when one works with pre-schoolers,the learning disabled and the mentally retarded. One of the particular problems frequently encountered with children is the lagging of accommodative responses that can mask cases of esophoria or esotropia during standard testing. It is essential in the examination of children to know as precisely as possible how accurately the child accommodates for a nearpoint stimulus. If the child is not consistently accommodating proper amounts, ~~or accommodating~~ a significent eso imbalance may be completely hidden in phorometric or cover tests.

One of the techniques commonly employed to evaluate accommodative status is dynamic retinoscopy. It has been applied by various methods over the years. Book retinoscopy,(2-5) Bell retinoscopy (6-8) and the monocular estimate method (MEM)(9-10) have been used successfully for many years.
Of these widely used dynamic retinoscopy techniques, Bell retinoscopy is the only one that probes accommodation while the patient actively fixates a moving target. The technique, as described by Apell and Streff,(7-8) provides clinical insight into lens prescribing for refractive errors and also binocular vision

disorders requiring the application of nearpoint plus.

One other test that objectively investigates accommodation and convergence in a similar manner to Bell retinoscopy is the kinetic cover test or KCT, introduced by Griffin.(11) The technique involves performing an alternate cover test while the patient watches an approaching and then receding target. With the target 50 cms from the patient, the examiner evaluates the alternate cover test. The fixation target is then moved toward the patient along the midline. As the patient follows the movement, the examiner will see a change in the amount of phoria dependent on the AC/A ratio and the amount of accommodation taking place. After reaching a point close to the patient's eyes,the target is moved away. The examiner continues the alternate occlusion throughout. When the target has returned to the starting position, there can be a change from the original phoria position. Usually, this is a shift toward less exophoria or greater esophoria. Sometimes a patient can even have an initial exophoria that becomes an esophoria as the target recedes. This eso shift probably represents a greater amount of accommodation for the 50 cm stimulus demand level than was present originally. It is thought that the continuous dissociation created by the occlusion and the target movement creates increased accommodation, more consistent with what is demanded.

There is an ever present need for valid and reliable objective clinical techniques for the optometric examination of children. This is especially true when evaluating accommodation and convergence at nearpoint since difficulty with these skills can have a direct impact on patient comfort and academic achievement.

The purpose of the present study was to investigate the relationship between these two dynamic nearpoint procedures, Bell retinoscopy and the KCT, to provide information about the mechanisms involved with the KCT.

Method

Subjects

274 children from a public elementary school (K-6) in western lower Michigan were visually screened using the Modified Clinical Technique. None of the children were classified as exceptional. Third and fifth grade students were used in the study. Those children with constant strabismus, anisometropia greater than 0.25 diopter or astigmatism greater than 0.50 were not included. A total of 58 subjects participated in the study, approximately equally divided between third and fifth graders, and according to sex.

Procedure

Bell retinoscopy was administered by one author (RG) and the KCT by the other (JR) allowing consistency of observation. Both examiners were familiar with the clinical use of Bell retinoscopy and cover test interpretation. Each examiner compiled the results independently without knowledge of a child's performance on the other test.

The procedure for Bell retinoscopy was very similar to that described by Apell. The subject was seated with the examiner positioned on eye level with the subject, approximately twenty inches away, on the mid-line. The end of a yard stick was held by the subject at the outer canthus of the eye to be examined. The other end of the stick was placed on the examiner's shoulder. A clear plastic 30 mm sphere was used as the fixation target. When looking into the sphere the subject saw an inverted image of the examiner's face. It has been previouslly been previously demonstrated that this makes an effective accommodative stimulus for Bell retinoscopy. (12) The sphere was positioned 20 inches from the subject and moved slowly toward the child on the midline. As the sphere was moved forward, the horizontal and vertical meridians of both eyes were evaluated retinoscopically. Any subject that developed a significant anisometropic or astigmatic reflex was not included in the study. Four subjects were excluded for this reason. After it was determined that the reflexes remained equal and spherical, the experimental session was begun. Because the retinoscopic reflex was basically spherical, observations were confined to the horizontal meridian only.

The sphere was returned to a position 20 inches from the subject and the retinoscopic reflex evaluated. With the sphere this far away from the subject, with motion of the reflex was seen. As the sphere was moved toward the subject, the amount of this with motion gradually reduced until the reflex changed to against motion. The distance (in inches) from the subject's eye that the first against motion was seen was recorded. An assistant, using the yardstick, determined this point to the nearest 0.5 inch. After this, the sphere was moved outward until a return to with motion was observed. This point was also recorded by the assistant.

The kinetic cover test (KCT) was administered in the following manner. The clear plastic sphere (same as used in the Bell retinoscopy procedure) served as the fixation target. It was held at a distance of 40 cms (16 inches) from the subject, in the midline at eye level. 40 cms was chosen because this is the traditional nearpoint test distance. An alternate cover test was performed, with the examiner estimating the direction and magnitude of the phoria. The target was now moved inward, slowly, at the same speed as in Bell retinscopy, (approximately 1 inch/second) with the examiner simultaneously continuing the alternate occulsion. The occlusion was alternated at a rate of approximately once per second. Estimates of the change in the phoria were taken as the target moved. When the target reached a point about 5 cms from the subject's nose, it was moved away and back to the 40 cms starting position, with the alternate occlusion continuing throughout. The examiner then compared the amount of phoria at this point with the amount of phoria present at 40 cms when the testing began.

The subjects were placed into two groups depending on their responses to the Kinetic cover test. Group E (equal) represents those children whose initial phoria estimate at 40 cms was not significantly different (less than a 5 prism diopter eso shift from the final phoria estimate at 40 cms. Group NE (not equal) were those children whose final 40 cm. phoria was significantly different (5 prism diopter or greater eso shift) from the initial phoria estimate.

Results

21 of the 58 subjects (36%) gave an NE response and 37 (64%) gave an E response. A comparison was made between the Bell retinoscopy results of these two groups. The difference, in inches, between the occurrence of against motion and the return to with motion was determined for each subject and the mean calculated for each group. The mean difference for Group E was 2.70 inches (s=.75) and 3.14 inches (s=.73) for group NE. A student's t-test was performed for statistical inference. The results indicate that there was statistically significant difference in the with-against interval between the two groups ($p < .05$).

The occurrence of the first against motion, in inches, was also used to compare the two groups. The results of statistical analysis indicate that there was no significant difference between the groups ($p > .10$, mean group NE=14.93 inches, s=1.86, mean group E=15.86, s=2.08).

Discussion

The results suggest that when a significant eso shift occurs during the kinetic cover test, it is likely that there will be a delayed shift back to with motion on Bell retinoscopy. This finding is consistent with the presumed mechanism of increased accommodation during the kinetic cover test as the target recedes from the patient. It appears that the process of kinetic testing yields a more valid measure of the nearpoint phoria by producing a more reliable accommodative response.

For the purposes of this study, we have chosen a 5 prism diopter shift in the kinetic cover test as the critical amount instead of the actual presence of 5 prism diopters of esophoria as suggested by Griffin(11) for several reasons. If a patient has a small amount of exophoria or orthophoria as seen by a standard nearpoint cover test, it might be concluded that there is little chance of a vergence anomaly. If however, a small amount of esophoria is exposed during kinetic testing, a different conclusion is possible. The presence of nearpoint esophoria is often indicative of an accommodative disorder and the presence of possible visual stress(13)and in children may herald the development of myopia or further progression of myopia.(14-15)

The kinetic cover test can also be useful in cases of high nearpoint exophoria or intermittent exotropia for the differential diagnosis of convergence in-sufficiency. If during the kinetic testing there is a significant reduction in the amount of exophoria, it is likely that a pseudoconvergence insufficiency is present, indicating a significant accommodative component to the exophoria which would lead to a significantly different treatment approach for the convergence problem.

Apell(7) states that in a normal response with Bell retinoscopy, the initial with motion should change to an against motion from 17 to 14 inches from the subject. This shift tended to occur somewhat closer to the subject in the NE group, indicating greater plus acceptance, again suggesting that they did not accommodate as fully as the subjects in group E.

The results also suggest an alternative method of analyzing the against to with shift. Apell (7) states that this shift should occur from 15-18 inches from the patient but the linear size of the against-to-with interval has never been ~~really~~ investigated. Our results suggest that the against-to-with shift should occur at a point approximately three inches from the with-to-against shift. Any result greater than this would be a sign of accommodative ~~infacility~~. dysfunction.

It is interesting to note that over one-third of all children tested (36%) demonstrated a significant eso shift (~~NE response~~) on the kinetic cover test. This has important clinical implications; namely, that the standard static alternate cover test and possibly other phorometic tests do not reliably measure the nearpoint phoria in a large number of children. Because the phoria is considered the reference point for comparison to compensatory fusional vergence ranges in most optometric nearpoint analysis systems, then a ~~valid~~ reliable measure of the phoria is of utmost clinical importance. By use of the Kinetic Cover Test and Bell retinoscopy, it is possible to identify situations when accommodative responses and hence phoria measurements are not appropriate. They also have potential clinical value for inclusion in vision screening that use cover tests, e.g., the modified clinical technique, and in the evaluations of very young children and the developmentally disabled because of increased attention holding properties of a moving target to a steady one.

References

1. Hofstetter, H. The zone of clear single binocular vision. American Journal of Optometry and the Archives of the American Academy of Optometry, Part 1, 1945, July 301-333; Part II, August, 361-384.

2. Pfeiffer, C. H. Book retinoscopy. American Journal of Optometry and Archives of the American Academy of Optometry, 1955, October, 540-545.

3. Macdonald, L.W. A theory for interpreting book retinoscopy observations. Optometric Weekly, 1962, July 19, 1446-1447.

4. Getman, G.N. Techniques and diagnostic criteria for the optometric care of children's vision. Optometric Extension Program, 1960.

5. Gesell, A., Ilg. F.L., and Bullis, G.E. Vision, Its Development in Infant and Child. Darien, Conn: Hafner, 1970.

6. Pomeranz, R.B. The use of bell retinoscopy to determine the nearpoint prescription. Optical Journal and Review of Optometry, 1964, December 21-24.

7. Apell, R.J. Clinical application of bell retinoscopy. Journal of the American Optometric Association, 1975, October, 1023-1027.

8. Apell, R.J. and Streff, J.W. Optometric child care and guidance. Optometric Extension Program, 1962.

9. Bieber, J.C. Why nearpoint retinoscopy with children. Optometric Weekly, 1974, January 17, 54-57; January 24, 78-82.

10. Haynes, H.M. Clinical observations with dynamic retinoscopy. Optometric Weekly, 1960, October 27, 2243-2246; November 3, 2306-2309.

11. Griffin, J.R. Binocular Anamalies, Procedures for Vision Therapy, Chicago, ILL. : Professional Press, 1976.

12. Garzia, R.P., Richman, J.E. and Durkee, D., Description of a novel fixation target for the examination of young children. The Michigan Optometrist, 1982, March, 8-9, 16.

13. Manas, L. Visual Analysis, 3rd ed. Chicago, ILL. : Professional Press, 1965.

14. Oakley, K.A. and Banford, R.D. Evaluation of bifocal correction technique in juvenile myopia. Optometric Weekly, 1967, October 26, 19-26.