COMPARATIVE STUDY OF DYNAMIC NEAR-POINT REFRACTION ASSESSMENT

by

Duane Tolsma and Mark Swan

Mark Koscuiszko, O.D., Faculty Advisor

1988

ABSTRACT: Two forms of common clinical assessment of dynamic near-point refraction are compared to one research model. Dynamic Retinoscopy Method of Nott and the Monocular Estimation Method have been used in the clinical setting for many years. A less familiar method of assessment from the laboratory setting is the Laser Optometer. A comparative study using each of the three techniques on 36 subjects was performed. The results and statistical analysis of the data will be discussed. The discussion will allow the reader to derive his or her own conclusion regarding the feasibility and viability of each technique.

INTRODUCTION: Assessment of lag of accommodation has been included in the clinical arsenal for many years now. It is a proven subjective test. Results of which are valuable in diagnosis of many anomalies of the visual system. Including: Determination of near-point lens prescription, differential diagnosis of accommodative convergence problems, and objective 1,4 determination of amplitude and facility of accommodation. Nott Retinoscopy and Monocular Estimate Method have been chosen from the long list of techniques of dynamic near-point refraction assessments because of their common use in the clinical setting and ease of performing the techniques. Each dynamic technique has its positive and negative attributes, dependent on the information that the observer is looking for. For this study, only the objective endpoint results of the techniques will be used. The subjective interpretation is a skill mastered by experience and will not be considered here.

The results of the two aforementioned techniques are compared to the results of a Laser Optometer built by J. James Saladin, O.D., Ph.D. located at Ferris State University, College of Optometry. The optometer is an optical device based on a design from the mid 1700's.[2] The laser optometer is a well accepted method of measuring the absolute lag of accommodation. Each of the above have been performed on 36 subjects.

The results of the three techniques are compared independently and assessed for repeatability. Data is analized comparing the techniques to each other showing a significant correlation.

DESCRIPTION: Dynamic Retinoscopy Method of Nott is performed in the clinical environment by having the subject view a target at 40cm, while the observer neutralizes a retinoscopy reflex by moving the retinoscope closer to or farther from the spectacle plane. Endpoint is neutrality and is commonly measured from the target in centimeters and converted into dioptic values. The average endpoint, as determined by Nott in 1925,[3] is approximately +0.75 diopters of lag.

Monocular Estimate Method is performed by having the subject view a constant target at 40cm. The observer holds a retinoscope at the target and neutralizes the retinoscopy reflex by inserting trial lenses at the spectacle plane of the subject. Care is taken to leave the trial lens at the spectacle plane no longer than one half second. This is to prevent the subject from accommodating in reaction to the change in vergence of light created by the trial lens. Average clinical findings are 5 +0.50 to +0.75 diopters of accommodative lag.[5] Rouse concluded from his study of Monocular Estimation Method and Phoroaccommodometer results that Monocular Estimation Method is a useful clinical test.[5]

As previously mentioned, the Laser Optometer is an optical device used to determine the refractive state of the subject. The optometer can be used at any distance but for this study a fixation target of Snellen letters located 40cm from the spectacle plane will serve as the subject's object of regard. The resultant refractive state measured by the optometer can be assumed to be the lag of accommodation. A complete description of the optometer is necessary to explain the previous statements. An optometer incorporates a Badal optical system that is adjustable(see diagram). This introduces either a convergent or divergent image to the subject by adjusting the object distance from the Badal collimating lens (H).

In the Laser Optometer a speckle patten image is generated by a laser beam (A) passing through an expanding system of lenses (C) and illuminating a diffuse surface (E). A flashing occluder (B) is placed in the beam path to prevent the subject from constantly studying the speckle. The diffuse surface image is a rotating cylinder which causes the speckle pattern to appear to flow. Because the image is kinetic and on a cylindrical surface the perceived plane of regard is not at the surface of the cylinder. A formula derived by Charman[6] results in the plane of regard being located exactly halfway between the center of rotation of the cylinder and the surface of the cylinder (F).

The cylinder and respective plane of regard are mounted on an adjustable track. The position of the plane of regard is controlled by a toggle switch operated drive system. By moving the plane of regard upstream and downstream to the focal point of the 10 diopter, collimating, Badal lens divergent or convergent light is presented to the subject. Divergent or convergent light causes the subject to perceive movement in the speckle pattern, either upward or downward "flow". When the subject views the fixation target (J) at 40cm, the focal point of their eyes is located at a distance greater than 40cm. This is their lag of accommodation. The Laser Optometer is adjusted so that the vergence of the light of the optometer image is equal to the vergence of the focal point of the eye. At this point, the subject will perceive no movement in the speckle pattern. Given that the Badal lens is 10 diopters a direct correlation can be drawn from the object distance to the vergence of the light leaving the system. This is one centimeter to each diopter of vergence. The endpoint denotes optically where the focal point of the eye is. However, we are interested in the lag of accommodation. Therefore, we must subtract out the position of the fixation target dioptrically to give the difference between the subject's point of regard, Snellen letters, and the actual focal point of the eye, optometer measurement.

METHOD: A subjecct base of 36 university students was drawn. Ages ranged from 21 to 36 years. Each subject was required to have best corrected acuities of 20/20 or better. A phoria of less than eight prism diopters of eso or exo deviation and stereopsis of 80 seconds of arc or better was also required.

Testing took place in a darkened room with the subject seated at a table. The instrument contained all necessary equipment, therefore, the subject remained at this station until all tests were completed (see diagram). The subject is instructed to keep his/her head against the forehead rest. The fixation target (J) is located 40cm from the spectacle plane and is backlit to provide high contrast while allowing the room to remain dark for retinoscopy. Immediately in front of the spectacle plane are two beam splitting prisms (I). The subject looks through the prisms to the fixation target. At the same time light at 90 degrees from the prisms can be directed to the eyes and superimposed on the retina.

In the first technique the laser generated speckle pattern is directed to the retina of the left eye via the beam splitting prism. The subject was instructed to look straight ahead at the fixation target (using the right eye) and keep this image clear. The subject can see the speckle pattern superimposed on the target via retinal correspondence. The speckle pattern appears to flow either up or down. By means of a hand held toggle switch the subject adjusts the pattern of the speckle to the point where there is no movement. Subjects were instructed to "bracket" this point while maintaining a clear image of the fixation target. Three endpoint measurements were recorded for each subject.

The second technique performed is the Dynamic Retinoscopy Method of Nott. This was performed at the same station using the same fixation target. The subject was again instructed to maintain a clear image of the fixation target (this time with the left eye). A Keeler streak retinoscope (K) was used by the observer to the right of the subject. The streak is directed to the retina of the right eye via the beam splitting prism (I). With the patient holding fixation on the snellen letters the observer neutralized the retinoscopy reflex by moving the retinoscope closer or farther from the spectacle plane. Neutrality was recorded by means of a meter stick zeroed at the spectacle plane. Three measurements were recorded in centimeters.

The final technique is the Monocular Estimate Method also performed through the right beam splitting prism while the subject maintains a clear image of the fixation target (left eye). The retinoscope was held 40cm from the spectacle plane and the retinoscopy reflex of the right eye noted by the observer. Trial lenses were inserted at the spectacle plane of the right eye. Neutrality was determined by bracketing with different power trial lenses and this lens power recorded.

RESULTS: Statistical analysis was performed on the data. The three trials for the Laser Optometer and Nott Retinoscopy were averaged for each patient and converted to dioptric value. These values are referred to as Laser Optometer Lag and Nott Lag. This simplifies the statistical calculations by limiting the data for each patient to three raw scores of common unit value. The mean for the Laser Optomer Lag was found to be +0.595 diopters. A standard deviation of 0.230 shows that the comparison of results between the different subjects is of statistical significance. The mean for the Nott Lag was found to be +0.611 diopters with a standard deviation of 0.251. The Monocular Estimate Method showed a mean value of +0.694 diopters and standard deviation of 0.247. Statistics were calculated on the entire n=36 subject group.

Although the initial results appear to be similar, Correlative Statistical Analysis did not show a clear correlation between the three techniques. When comparing Laser Optometer Lag to Monocular Estimate Method Lag a correlative value of 0.515 was calculated. Correlation between Laser Optometer Lag and Nott Lag was calculated at a dismal 0.346. The correlation between the two established clinical methods was 0.468. Also indicating marginal statistical significance.

CONCLUSION: The results of this study did not show conclusively that there is a significant correlation between the three techniques. However, the inconclusive results should not discount the validity of the techniques. Upon review of the study a number of design flaws were noticed. Correction of these factors may very well improve the statistical result in a repeated study. Accuracy of the Laser Optometer mechanism can be improved for higher tolerances. The repeatability of the two observers retinoscopy skills can not go without question either. A more demanding fixation target may be devised to better hold the subject's attention.

A study comparing the Laser Optometer to the Phoroaccommodometer[7] may also be of value. This would limit the possibility of observer error. In addition, the Phoroaccommodometer has already been accepted as a reliable research instrument.

The two clinical techniques have already passed the test of time and are considered by many to be clinically useful. The Laser Optometer may become a valuable addition to the testing arsenal only if the tolerances are tightened.

BIBLIOGRAPHY

1 Dunsky, Irving L. Various Retinoscopies as Measures of Different Visual Functions. Southern Journal of Optometry, 1987, 4-8.

2 Guyton, David L. Automated Clinical Refraction. Clinical Ophthalmology, Thomas, Duane D. ed., Chap. 67, 1,2.

3 Borish, Irving M. Clinical Refraction (Third Edition), Professional Press Inc., Chicago, IL 60602, 697-712.

4 IBID. 704.

5 Rouse, M.W., London, R., & Allen, D.C. An Evaluation of the Monocular Estimate Method of Dynamic Retinoscopy. American Journal of Optometry and Physiological Optics, 1982, 59 (3), 234-239.

6 Charman, W.N. On the Position of the Plane of Stationarity in Laser Refraction. American Journal of Optometry and Physiological Optics, 1974, 51, 832-838.

7 Allen MJ. The Phoro-accommodometer and the AC/A Ratio. Am J Optom Physiol Opt 1960; 37(9): 483-487.

A. LASER
B. ROTATING OCCLUDER
C. COLLIMATING LENS
D. MIRROR
E. ROTATING DIFFUSING SURFACE
F. STATIONARY PLANE
G. MOVEABLE SCALE
H. CONVERGING LENS
I. BEAM SPLITTER
J. BACK-ILLUMINATED TARGET
K. RETINOSCOPE