Correlation of Visual Symptoms with Near Vergence Range and Near Vergence Facility Measurements

BY

Jamey Wolbert

Associated with Joshua Lotoczky

J. James Saladin, O.D., Ph.D.
Faculty Advisor

March 14, 2004

Correlation of Visual Symptoms with Near Vergence Range and Near Vergence Facility Measurements

By Jamey Wolbert

Associated with Joshua Lotoczky

Abstract

An investigation of whether visual symptoms of asthenopia are related to near vergence ranges and vergence facility ranges was completed in an optometry school setting. The study consisted of 49 optometry school students. Given patients with normal visual acuity and normal phorias, no statistically significant difference was found between asymptomatic and symptomatic patients when tested for near vergence ranges and near vergence facility.

Introduction

Vergences are disjunctive eye movements, the opposite of conjugate movements such as versions. Vergences were classified into four categories by Maddox: tonic, accommodative, fusional, and proximal. Vergence movements are slow as compared to saccadic or tracking movements, and usually involuntary.

Convergence and divergence movements are necessary when changing focus from distance to near objects and vice versa. The stimulus for fusional vergence movements of the eye is retinal disparity. Fusional or disparity vergence is the only one of the above four types of vergence movements that responds to retinal disparity directly. It is responsible for reducing the amount of retinal disparity to maintain single binocular vision.[1] In the clinical setting, this disparity is created using prisms in order to keep test distance constant. Fusional divergence is tested prior to convergence to avoid base-out

prism adaptation. The patient is instructed to attempt to keep a 40cm nearpoint target clear and single, then report blur, break, and recovery points.[3]

Morgan's research established normative values for vergence ranges. His expected criteria for passing negative relative convergence or base-in near testing are break 21^{Δ} (prism diopters) ± 4, with $\leq 16^{\Delta}$ BI as the cutoff for symptomatic criteria. For positive relative convergence or base-out near testing, the criteria are break 21^{Δ}, ± 6, with $\leq 15^{\Delta}$ BO as the cutoff for symptomatic criteria.[2]

Vergence facility describes the ability to change from convergence to divergence repeatedly and accurately. It is dependent on the speed and amount of vergence movements. The results can be conveyed objectively by observation or subjectively by patient response. The subject fixates a near point target, and then a prism is inserted in front of one eye. A vergence movement should then be made by that eye to fuse the target. Vergence facility is quantified by the number of cycles of BI and BO fusion performed in a given time. A standardized amount of prism can be used such as the Wick prism (3^{Δ} BI/12^{Δ} BO). A normal (expected) result for the Wick prism at 40 cm is 15 cycles per minute ± 3, with a ≤ 12 cycles per minute cutoff for symptomatic criteria.[2] The observer can also note quality of the vergence system by observing which direction the subject appears to have the most difficulty, if any.

Several studies have investigated the role of vergence and vergence facility in visual symptoms. Gall et al wrote, "Given a patient with asthenopia, normal phorias and visual acuity, a differential diagnosis may be made based primarily on using vergence facility and accommodative facility testing. Form a clinical standpoint, the results expedite diagnosis of binocular vision abnormalities and direct treatment."[2]

The goal of our research was to see if visual symptoms were related to vergence range and vergence facility values in our test group.

Methods

Subjects were recruited voluntarily from second and third year classes at the Michigan College of Optometry. Subjects ranged in age from 22-36 years old. Visual acuities with correction were 20/25 or better. There were no restrictions on gender or race. The subjects signed a consent form agreeing to participate in the study, which was approved according to Ferris State University's Human Subjects Research Protocol.

Subjects were separated into symptomatic and asymptomatic groups based on their responses to a survey about frequency of visual-related symptoms given prior to testing. Of the 49 total subjects, the 16 subjects with the lowest number of positive responses to visually significant symptoms were labeled "asymptomatic" and the 16 subjects with the highest number of positive responses were labeled "symptomatic." Horizontal phorias were measured at near using a phoropter with Risley prisms with the nearpoint letter chart on the Saladin Near Point Card (SNPC) as the near target. Vergence ranges at near were measured with a bar prism (base in and base out) using the nearpoint letter chart on the SNPC. Subjects were asked to report blur, break, and recovery of the single image on the card. Vergence facility at near was also measured using the nearpoint letter chart on the SNPC with a Wick prism (3^{Δ} base in; 12^{Δ} base out), again asking the subject to report fusion of the target. Facility values at 30 seconds and 60 seconds were recorded for each subject. Statistical analysis was then performed to determine of there was a significant difference between the two groups' results on near base-in/base-out vergence and near vergence facility testing.

Results

Using an unpaired, two-tailed t-test for between-group differences, t values were calculated and associated p values were determined. Degrees of freedom were equal to n-2 or 30 for the sample size of 32.

Mean near horizontal phorias for the control group (asymptomatic) were 0.06^{Δ} of exophoria ± 3.94, and mean phorias were 1.25^{Δ} of exophoria ± 3.91 for the symptomatic group. There was no statistical significance between these two values for the groups ($t = 0.8559$, $p > 0.05$, $df = 30$).

Vergence results were as follows: for base-in vergences, BI to blur mean was 13.00^{Δ} ± 3.50 in asymptomatic group, 13.00^{Δ} ± 3.72 in the symptomatic group. BI to break mean was 15.31^{Δ} ± 4.21 in asymptomatic group, and 16.00^{Δ} ± 4.99 in the symptomatic group. BI recovery mean was 12.00^{Δ} ± 4.50 in the asymptomatic group, and 12.00^{Δ} ± 4.20 in the symptomatic group. There was no statistical significance between the two values for the groups in blur, break or recovery values (*blur:* $t = 0.000$, $p > 0.05$, $df = 30$, *break:* $t = 0.4212$, $p > 0.05$, $df = 30$, *recovery:* $t = 0.000$, $p > 0.05$, $df = 30$). Eleven subjects (68.75%) in the asymptomatic group failed to meet the passing cutoff criteria for near BI vergence, while ten of the subjects (62.5%) in the symptomatic group failed to meet the same criteria.

For base-out vergences, BO to blur mean was 23.88^{Δ} ± 10.37 in the asymptomatic group, and 24.69^{Δ} ±10.50 in the symptomatic group. BO to break mean was 28.56^{Δ} ± 9.52 in the asymptomatic group, and 32.69^{Δ} ± 7.09 in the symptomatic group. BO recovery mean was 22.38^{Δ} ± 7.74 in the asymptomatic group, and 26.88^{Δ} ± 8.29 in the symptomatic group. Again, there was no statistical significance between the two values

for the groups in blur, break or recovery values (*blur:* $t = 0.2203$, $p > 0.05$, $df = 30$, *break:* $t = 1.3901$, $p > 0.05$, $df = 30$, *recovery:* $t = 1.5871$, $p > 0.05$, $df = 30$). Two subjects (12.5%) in the asymptomatic group failed to meet the passing cutoff criteria for near BO vergence, while all of the subjects in the symptomatic group met the passing cutoff criteria.

Vergence facility results for the asymptomatic group were as follows: mean vergence facility of 17.31 cycles per minute (cpm) with a standard deviation of 7.22. Vergence facility results for the symptomatic group were mean vergence facility of 14.88 cpm with a standard deviation of 6.32. There was no statistical significance between these two values for the groups ($t = 1.0161$, $p > 0.05$, $df = 30$). Three of the sixteen subjects (18.75%) in each group (asymptomatic and symptomatic) failed to meet the cutoff passing criteria of 12 cycles per minute.

Discussion

Based on the t-test results, the answer to the research question is no, there was not a significant difference between the near vergence range and near vergence facility test results for our symptomatic and asymptomatic groups. Specifically, the vergence ranges in the two groups were almost identical and showed very low values on t-test for clinical significance between groups. In fact, the symptomatic patients actually had higher mean vergence ranges for both base-in and base-out vergence testing. Although the asymptomatic group did have a higher mean value for vergence facility, the difference between the two groups again was not statistically significant.

These results indicate either that there is no significant correlation between visual symptoms and the results of the vergence and vergence facility measurement, or that the

method of surveying visual symptoms did not correctly identify those with true vision-related symptoms. This result for the vergence facility testing is, however, consistent with Gall et al's study published in 2003, which also found no statistically significant difference between vergence facility values in the presence and absence of symptoms.[2] Although only three of our sixteen symptomatic subjects failed to meet the cutoff criteria for symptomatic vergence facility (≤12 cycles per minute), six of them scored below normal (≤15 cycles per minute). This suggests that reduced vergence facility is indicative of visual symptoms.

Visual symptoms can vary from day to day among patients. In a more in-depth analysis of visual symptoms, a log would be needed tracking visual symptoms over a given period of time rather than just a snapshot view of a person's subjective visual symptoms on any one day. A two-week to one-month journal-type log of visual symptoms would give a much more accurate account of the true severity of patient symptoms and would be more beneficial to separate groups as truly asymptomatic and symptomatic.

Several nearpoint tests have been developed to assist clinicians in deciphering patients complaints and offering solutions. Vergence ranges and vergence facility have certainly been proven as useful diagnostic indicators in the past and will continue to be used in the future.

References

Benjamin WJ. *Borish's Clinical Refraction.* WB Saunders 1988: 121-156.

Gall R, Wick B. The symptomatic patient with normal phorias at distance and near: what tests detect a binocular vision problem? *Optometry* 2003:74:309-322.

Griffin JR. *Binocular anomalies: diagnosis and vision therapy.* Butterworth-Heinemann, 1995: 44-72.