Convergence Excess:
Is There An Easier Way to Diagnose It?

by:

John William Muir
Optometry Student, Michigan College of Optometry

1998

Advisor:

Daniel Wrubel, O.D.
Associate Professor, Michigan College of Optometry

Abstract

Deficiencies in binocular vision can result in a myriad of problems for a patient, including headaches, diplopia, asthenopia, and blurred vision, just to name a few. Convergence excess is one of the most prevalent vision disorders, yet there are many theories on diagnosing it. The author theorized that by measuring the base-in (BI) vergences at near and dividing the value by the results of the kinetic cover test, the clinician would come up with a number, a convergence excess (CE) factor, which would help determine whether or not someone is suffering from convergence excess.

Forty-one individuals from the Michigan College of Optometry and a private practice in Michigan served as subjects for the study. In patients that report significant symptomology, 89% showed a CE factor of less than or equal to eight, whereas those with minimal symptomology showed a CE factor of greater than eight 71% of the time.

Introduction

Deficiencies in binocular vision can result in a myriad of problems for a patient, including headaches, diplopia, asthenopia, and blurred vision, just to name a few. Optometrists are taught how to diagnose and treat these binocular vision disorders. However, many are not interested in diagnosing these conditions, and even more are disinterested in treating them. The reasons vary, ranging from a misunderstanding of binocular vision, the fact that many insurance companies do not cover vision therapy, inadequate office space and staff, and inadequate experience in diagnosing and treating these conditions in a clinical setting.

Convergence excess (CE) is one of the most prevalent vision disorders (Scheiman & Wick, 9). Convergence insufficiency, a more well-known condition, has been shown to occur in as high as 20% of patients (Wrubel & Garzia, 15). CE is approximately one and a half times as prevalent as CI (9). Determining the prevalence of this condition is highly variable due to the fact that there are many definitions of CE (Bennett, 1). It has been defined as an esophoria at near, greater than at distance, and inadequate negative fusional vergence ability, or poor base-in (BI) vergences at near (9). Some of the confusion with trying to diagnose this condition is the difference in the criterion used by practitioners. Some authors suggest a ten prism diopter difference from distance to near phoria (9). Yet another source describes CE in terms of symptomology, stating that problems occur with any nearpoint work, and include asthenopia, headaches, increasing difficulty seeing throughout the day, a tendency to fall asleep when reading, and decreased reading comprehension over time (Hokoda, 8). Others suggest a high accommodative convergence to accommodation ratio (AC/A) to diagnose (greater than 7/1) this disorder (9). Burian and VonNoorden summarized it well, by stating that the diagnosis of CE cannot be applied to a patient solely on distance and near deviations, but rather on the entire clinical picture of the patient (2).

Percival's criterion and fixation disparometry are two measurements that are commonly brought up in the literature regarding CE (9). Percival stated that the vergence demand should lie in the middle one-third of the range between the base-in and base-out blur points to provide comfortable binocular vision. This concept is studied in optometry school, but, unfortunately, it is not known whether or not this should be used in a clinical setting. Fixation disparometry, which has been studied extensively by Sheedy and Saladin, has been touted to provide clinicians with a more effective means of diagnosing and prescribing for oculomotor imbalance (11, 13). However, a majority of practitioners do not have a disparometer in their office and, therefore, most likely have minimal experience with this device. Sheedy and Saladin themselves state that a complete analysis of the oculomotor system should include phoria, vergence, and fixation disparometry testing, and that no single test is capable of analyzing a patient's binocular vision (11).

Thus far, it has been established that CE is a common condition in the clinical population, and that there are many ideas about how to diagnose it, as well as measurements that can be taken to aid in its diagnosis. However, the typical practitioner does not have the time nor the capabilities to do a complete binocular vison analysis on all patients. Therefore, a simple to understand and easy to do, clinically relevant way to diagnose CE would be beneficial to practitioners so that they could diagnose this condition and either provide treatment, or refer a patient to a binocular vision specialist for management.

Wrubel and Garzia did a study a few years ago that found an efficient way to diagnose convergence insufficiency by dividing the base out to break at near by the results of the near point of convergence (15). The value computed was determined to be a clinically significant way to determine whether or not a patient was having nearpoint difficulties due to convergence insufficiency. The author theorizes that by measuring the base-in (BI) vergences at near, as well as performing the kinetic cover test (KCT), which both involve using simple instruments available in nearly all practitioner's offices, this

condition can be diagnosed. By taking the results of the BI vergences at near and dividing it by the results of the KCT, the clincian would come up with a number, which would then determine whether the patient is suffering from CE so that appropriate vision therapy may be initiated.

Methods

Forty-one individuals from the Michigan College of Optometry and a private practice in Michigan served as subjects for the study. They ranged in age from eight to forty years old. Each was either emmetropic or correctable to 20/20 distance and near visual acuity and free of any ocular pathology. All of the subjects were esophoric at near, which was determined by the cover test along with loose prisms. Figure 1 lists eighteen questions that the patients were asked to answer regarding eye-related difficulties, in order to determine the degree of symptomology for each patient.

The base-in vergence range was determined using a prism bar. The prism bar had two prism diopter increments up to 20 prism diopters, then five prism diopter increments to a maximum of 40 prism diopters. The prism bar was placed in front of the right eye of each subject. A vertical column of reduced 20/20 letters served as the target. The target was positioned on the midline slightly below eye level at a distance of 40 centimeters. The subjects were instructed to keep the target single, and to note when it blurred, as well as when it doubled. The vergence demand was presented in incremental steps approximately every three seconds. The vergence range was determined when the subject reported blurred or double vision, or when the clinician saw one eye deviate away from the target. Afterwards, the vergence demand was incrementally decreased until the patient reported single vision.

A kinetic cover test result was determined using a target and a cover paddle. The target used was a reduced block of 20/20 letters, which was held at a distance of 50

centimeters from the patient in the midline at eye level. An alternating cover test was performed, with the clinician noting the amount of esophoria seen objectively. The target was then moved inward, slowly, at approximately three centimeters per second with the clinician continuing the alternating cover test throughout the measurement. The clinician alternately covered each eye for one second each.

When the target reached a point about five centimeters from the subject's nose, it was quickly moved away back to the initial 50 centimeter starting distance, continuing the cover test. The clinician then compared the amount of esophoria at the end of the test with the amount at the beginning. The results of this test can be used to evaluate accommodation and convergence in a patient. Garzia and Richman hypothesize that this test provides a more accurate measurement of the phoria at near by utilizing a better accommodative stimulus (5). If a patient shows a five prism diopter or greater esophoric change from the initial phoria measurement to the measurement taken immediately after stress is placed on the eyes, it is thought that they are either over-accommodating or over-converging during nearpoint activities throughout the day.

Results

Looking at how all of the subjects did on the various tests, a picture can be drawn of the "typical" nearpoint esophore. On average, they were orthophoric at distance and two prism diopters of esophoria at near. Their base in to recovery were measured at an average of thirteen prism diopters. They had a 51% chance of showing a KCT result of at least a five prism diopter shift during testing. This is an important finding. If Garzia and Richman are correct in their hypothesis, half of all nearpoint esophores have probable accommodative and/or vergence dysfunctions.

After reviewing responses to the yes/no questions, patients were placed into two groups: either symptomatic or asymptomatic. Nineteen patients fell into the symptomatic

group based on this criterion, whereas twenty-two were deemed asymptomatic. The BI recovery, as measured in prism diopters, was placed in the numerator of the fraction. If a patient showed at least a five prism diopter shift during the KCT, they were given a value of three. If they showed less than five prism diopters, they were given a value of one. This number was placed in the denominator of the fraction. An example of calculating this value is given in Figure 2. The symptomatic group showed an average value of 4, whereas the asymptomatic group showed an average value of 12. The data is shown in Figure 3.

Discussion/Conclusions

Several years ago, a study was done to develop an easy to do testing protocol to determine symptomology in people who showed exophoria at near (15). By dividing the results of the base-out break at near by the nearpoint of convergence, a factor was determined (called the Symptom factor, or S factor). If a patient showed an S factor of less than or equal to five, they tended to show clinically significant symptomology and would benefit from vision therapy. Based on the results of this study, the author wanted to determine whether or not an "S factor" could be calculated that could be used for those that were esophoric at near.

It was known that BI ranges at near are indicators of negative fusional vergence ability. Also, the kinetic cover test would provide information about a patient's reaction to visual stress at near. The BI recovery measurement, in particular, would give objective information regarding the ability of the visual system to recover from stress at near as well. Therefore, it was thought that a ratio, or "CE factor" could be determined using the results of the aforementioned tests. No mathematical or physiological principles were involved in determining this ratio.

The results of this study show that, in those patients that have significant symptoms, approximately 89% showed a CE factor of less than or equal to eight. On the

other hand, those with minimal or no symptoms showed a CE factor of greater than eight 71% of the time. These figures support the fact that CE could be diagnosed fairly accurately on the basis of the results of the CE factor.

This paper provides information that can be used immediately in any office. A practitioner reading this study can gather information about the characteristics of CE. When in doubt, practitioners should not hesitate to consult with a binocular vision specialist if vision is 20/20 and yet symptoms persist with the best spectacle correction. Numerous studies show the efficacy of vision therapy. Gallaway et. al. showed that symptoms due to CE were diminished for 75% of patients after therapy (4). They also found that even though nearpoint esophoria tends not to change after therapy, significant increases in BI ranges were achieved, as well as improved accommodative facility. Ficarra et. al. found a decrease in patient complaints of headaches, blurred vision, and other visual symptoms (3). It is not the author's purpose to show that vision therapy is an effective form of treatment. This has already been shown by many well-controlled studies.

By asking patients a few extra questions either on your case history form or talking with them, any practitioner can determine whether or not a patient is symptomatic, and may have a binocular vision problem. If the patient is young and reports no complaints, the parent could be asked about reading abilities, avoidance of near work, and so on. Several forms that help gather information about the possibility of nearpoint stress have been developed and can be obtained from any practitioner that offers vision therapy. Convergence excess does not have to be underdiagnosed. With a little extra time, practitioners can successfully diagnose and treat this condition, making their patients happy and symptom-free.

Figure 1

Please answer yes or no to the following questions:

1. blurred vision at near? (Y/N)
2. double vision? (Y/N)
3. headaches associated with near work? (Y/N)
4. words run together when reading? (Y/N)
5. burning, stinging, watery eyes? (Y/N)
6. falling asleep when reading? (Y/N)
7. vision worse at the end of the day? (Y/N)
8. skipping or repeating lines when reading? (Y/N)
9. dizziness or nausea associated with near work? (Y/N)
10. head tilt or closing one eye when reading? (Y/N)
11. difficulty copying from the chalkboard? (Y/N) if applicable
12. avoidance of reading and near work? (Y/N)
13. omitting small words when reading? (Y/N)
14. writing uphill or downhill? (Y/N)
15. reading comprehension declining over time? (Y/N)
16. holding reading material too close? (Y/N)
17. short attention span? (Y/N)
18. car sickness or motion sickness? (Y/N)

Figure 2

Base-In Ranges: x/18/12 (blur/break/recovery)

Kinetic Cover Test: 6 prism diopter esophoric shift (positive KCT)

12/3 = 4 (since this value is less than 8, this patient would be diagnosed with CE)

Figure 3

Name	Symptomatic?	BI recovery	KCT > 5?	CE factor
SS	Y	8	Y	2.67
RL	Y	2	Y	0.67
JP	Y	12	Y	4
BC	Y	12	Y	4
RC	Y	14	Y	4.67
KS(2)	Y	12	Y	4
BB	Y	8	Y	2.67
LH	Y	25	Y	8.33
AK	Y	8	Y	2.67
JM	Y	10	Y	3.33
ES	Y	8	Y	2.67
MS	Y	18	Y	6
JL	N	14	N	14
ML	N	14	N	14
KS	N	12	N	12
AN	N	16	N	16
WO	N	18	N	18
LS	N	14	N	14
SC	N	16	N	16
MD	N	12	N	12
LS(2)	N	6	N	6
MR	N	18	N	18
CM	N	10	N	10
JJ	N	14	N	14
DC	N	18	Y	6
JR	N	16	Y	5.33
AA	N	12	Y	4
JS	N	12	Y	4
BM	Y	13	N	4.33
TC	Y	8	Y	2.67
CE	N	16	N	16
EL	N	16	N	16
LM	N	14	N	14
TL	N	14	Y	4.67
NB	N	14	N	14
CK	N	10	N	10
JN	Y	10	Y	3.33
TB	Y	4	Y	1.33
LF	Y	8	N	8
DS	Y	8	Y	2.67
AC	Y	10	N	10

Bibliography

1. Bennett, G. R. et. al. "A Review of Literature, Incidence, and Prevalence of Selected Visual Conditions". Journal of the American Optometric Association. 53:8:647-55.
2. Burian, H and VonNoorden, G. Burian-VonNoorden's Binocular Vision and Ocular Motility: Theory and Management of Strabismus. Saint Louis: CV Mosby Co., 1980. Second edition.
3. Ficarra, A.P. et. al. "Vision Training: Predictive Factors for Success in Visual Therapy for Patients with Convergence Excess". Journal of Optometric Vision Development. 27:4:213-19.
4. Gallaway, M. and Scheiman, M. " The Efficacy of Vision Therapy for Convergence Excess". Journal of the American Optometric Association. 68:2:81-6.
5. Garzia, R.P. and Richman, J.E. "Comparison of the Kinetic Cover Test with Dynamic Retinoscopy in Children". Journal of Optometric Vision Development. 14:2:3-6.
6. Griffin, J.R. and Grisham, J.D. Binocular Anomalies: Diagnosis and Treatment. Newton, MA: Butterworth-Heineman, 1995.
7. Hatch, S. "How to Diagnose Convergence Excess". Optometric Management. July 1994:44-50.
8. Hokoda, S.C. "General Binocular Dysfunctions in an Urban Optometry Clinic". Journal of the American Optometric Association. 56:7:560-2.
9. Scheiman, M. and Wick, B. Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders. Pittsburgh: J.B. Lippincott Co., 1994.
10. Sheedy, J. and Saladin, J. J. "Association of Symptoms with Measures of Oculomotor Deficiencies". American Journal of Optometry and Physiological Optics. 55:10:670-6.
11. Sheedy, J. "Fixation Disparity Analysis of Oculomotor Imbalance". American Journal of Optometry and Physiological Optics. 57:9:632-9.
12. Sheedy, J. and Saladin, J. J. "Phoria, Vergence, and Fixation Disparity in Oculomotor Problems". American Journal of Optometry and Physiological Optics. 54:7:474-8.
13. Teitelbaum, B. et. al. "Differentiation of Asymptomatic Patients from Symptomatic Patients by the Slope of the Forced Vergence Fixation Disparity Curve". American Journal of Optometry and Physiological Optics. 62:4:282-6.
14. Wesson, M. "Normalization of Prism Bar Vergences". American Journal of Optometry and Physiological Optics. 59:8:628-34.
15. Wrubel, D. and Garzia, R. " A Clinical Evaluation of the S (Symptom) Factor in Exophoria". Journal of Optometric Vision Development. 20:2:7-10.