EXAMINATION OF BINOCULAR VISUAL SENSATION OVER TIME WITH ROUTINE TESTING

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Abstract

Intermittent central suppression (ICS) is an afferent sensory defect in vision that interferes with detail vision producing symptoms of "dyslexia." Our knowledge of ICS has suffered due in part to a lack of routine testing. This paper proposes the routine use of ICS testing as developed by the author.

Key Words

intermittent central suppression, binocular refraction, vectographic refraction, dyslexia

Intermittent central suppression (ICS) is a time-related dysfunction of visual sensation.[1] Skeffington and others considered time effects on the visual system over spans presumed to be weeks, months, or years.[2,3] But, ICS disrupts vision over a much shorter course. Visual sensation in non-strabismics/non-amblyopics is apparently interrupted repetitively on a time course of seconds. Annapole[4] coined the term intermittent central suppression (ICS) and Strauss and Immermann[5] and Hussey refined the relationships and the diagnosis of this repetitive intermittent interruption of central visual sensation in non-strabismics. Hussey found a "typical" intermittent central suppression to be two to five seconds, occurring twice in a 10-second span, and covering a central visual area of one to three degrees visual angle. A typical time course for ICS then might show suppression of the central vision of one eye for approximately two seconds, then that suppression will resolve and either the other eye's central vision will suppress immediately, or after a two- or three-second period of binocularity, either eye's central vision will suppress for another few seconds.[1,6] The key finding is repetitive short-duration suppressions over time.

Hussey has postulated these repetitive losses of central visual sensation cause variability in central vision and therefore detail seeing by the interruption of sensory feedback for eye aiming. Such a variable central vision defect could logically be expected to affect reading, producing symptoms of "dyslexia." Hussey further suggested the Lateral Geniculate Nucleus (LGN) as a logical site for the neurological defect in ICS based on whiplash-produced suppression.[7] Recent electrophysiological evidence has given more credence to both the notion of a central vision dysfunction in dyslexia as well as the localization of the probable neurological defect in the area of the LGN. Functional MRI, VEP and ERG studies are suggesting a post-retinal and pre-cortical defect in dyslexia.[8,9] This same VEP data and a recent study of contrast sensitivity in "surface dyslexia" suggest visual deficits in dyslexia when targets favor central vision.[10]

Historically ICS has been tied to reading difficulties (dyslexia) and held as a target for correction with vision therapy. Louis Jaques, Sr., stated that correction of "suspension of vision" was the "first and most important" step in correcting vision problems with vision therapy.[11,12] Strauss and Immermann found ICS (their "macular suppression") correlated with poor reading performance in school children.[5] Whiplash cervical trauma can create ICS and impair reading in adults. Elimination of that trauma-induced suppression with vision therapy restored reading to subjective pre-trauma levels.[7]

Despite these links between ICS and reading suggesting ICS is a visual confusion-producing condition that will affect detail tasks such as reading, it remains hidden in the literature. One reason is that standard strabismus/amblyopia suppression tests typically miss non-strabismic and non-constant ICS. But, these same tests are often used to characterize binocular function.

A prime example of this errant commentary is stereopsis testing as often seen in the literature. The dominant thought about stereopsis testing is illustrated by Johansson and Jakobsson's recent statement that stereopsis is " ...the highest degree of binocularity."[13] But, in a group of ICS patients, Hussey documented that Wirt stereopsis, color lustre, the Worth 4-dot test and the Jampolsky 4-prism diopter test not only do not diagnose ICS, or even correlate with each other.[1] If we can agree that ICS is a defect in binocularity, then stereopsis as tested routinely cannot represent the highest degree of binocularity since its measurement is largely unaffected by ICS.

Strabismus- and amblyopia-derived tests are generally quick, "one-look" tests, often held as "special testing." The screening nature of such tests as stereopsis or the Worth 4-dot suggest a short time span of testing, rather than an evaluation of sensation over time. Indeed, one of the important attributes of these tests is that they can be used in virtually any test environment to screen for strabismus and amblyopia. The very attribute that makes these tests valuable in a screening environment, however, may preclude detection of ICS because of a primary characteristic of ICS - its intermittency or change through time.

This should not be taken to imply a test protocol can't be developed with strabismus-derived suppression or binocularity tests such as stereopsis to improve the evaluation of non-strabismic suppression (ICS). Developing such a test protocol that acknowledges the time-course of ICS should be encouraged. But, respecting the temporal aspects of ICS means the "visual snapshot" of typical strabismus-derived suppression screening tests is replaced with an evaluation of binocularity. Several ICS targets viewed successively over the several minutes of a thorough vision examination (or over a period of extra testing) combined with appropriate questioning changes that snapshot into a running commentary. The "snapshot" becomes a "video sequence."

Vision test protocols such as the Skeffington/OEP analytical examination[3] can be modified to maximize ICS yield.[1] Although the following tests can be considered as special testing, routine use within a standard analytical examination should be considered. Absolutely routine use of these tests allowed the discovery of whiplash-produced ICS. Holding ICS testing as "special testing" would quite possibly have precluded this discovery. But, by having routine ICS testing prior to an auto accident, both the examiner and the patient could see changes in the constancy of vision post-trauma. In this context of routine evaluation of the broadest population possible, special or perceptual testing is to be decried, not because it is unproven, or in error, or poorly understood;[14] but simply because it is "special." Unfortunately, routine testing of visual sensation over time is the antithesis of the time and testing restrictions of managed care. As special tests, these, or similarly documented ICS tests should certainly be used with patients complaining of reading or writing problems, "dyslexia," real-world depth perception problems such as catching a ball, headache, and those patients with a positive history of whiplash cervical trauma or chronic traumatic brain injury.

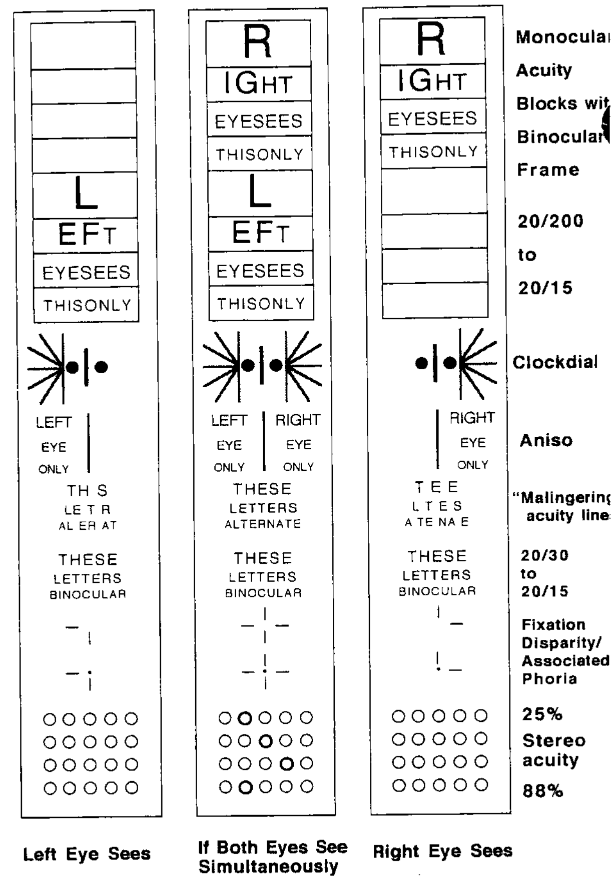

Figure 1. Schematic of adult vectographic projector slide.

Testing for ICS

Recently documented ICS tests focus on polarized and vectographic testing.[1,6,7,15] ICS can be evaluated at distance using a projected vectographic chart (Figure 1). Vectographic binocular refraction with a projected test chart has been promoted for routine examination since the 1960s.[a] Various advantages over typical monocular testing with binocular balance procedures have been suggested.[16-20] Inclusion of vectographic binocular refraction in a vision examination requires little modification of the exam routine, but allows questioning about any losses of visual sensation. Suppression will be seen as vectographic targets disappearing or, with children especially, "being erased and coming back."[15] The constant suppression of strabismus and amblyopia usually requires occlusion of the normally sighting eye for a vectographic target to be seen by the normally suppressed eye. This is another easily seen differentiation between ICS and strabismic/amblyopic suppression.[6]

Borish's (modified) vectographic near chart (Figure 2) provides the near binocular test targets.[b] Introduced in 1977, Borish emphasized the reliability and accuracy of binocular refractions as well as suggesting it could provide some "indication of suppression."[21] The lower diamond target is modified with added polarizers bisecting the diamond vertically so that the right eye sees the right side and the left eye sees the left viewed through the phoropter polarized lens bank filters. A suppression will be seen as the affected side blackening to the point that the underlying acuity letters cannot be seen. ICS diagnosis with this modified target correlates well to distance vectographic testing for ICS.[1] Although

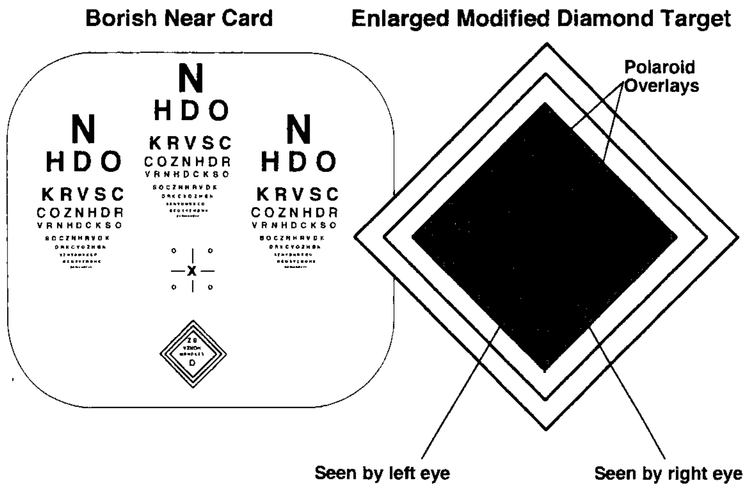

Figure 2. Schematic of original Borish vectographic near card modified with polarizers for ICS testing.

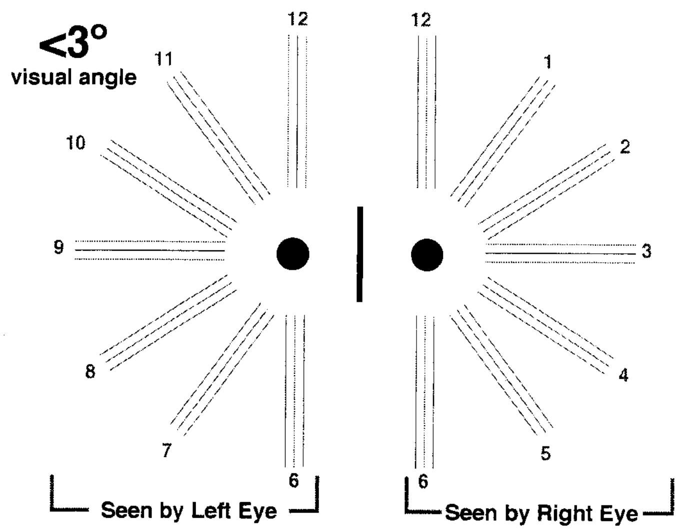

Figure 3. Schematic of vectographic clockdial target. Can you see the owl?

Figure 2 illustrates the original Borish test card, and it is no longer produced in this form, it should be understood that the modification of the diamond target was serendipitous. This most ICS-sensitive section of the card is primarily effective because of its size and easily identifiable changes. A similar target roughly two degrees across should yield roughly similar results.[1,6,7] Test-retest reliability of this ICS examination appears good.[1] The following tests that have been part of documenting ICS, its testing and its timing, are phoropter tests. Other tests documented elsewhere are stereoscope tests, and will not be discussed here.[4,5]

Distance ICS Testing

The projected distance vectographic chart serves as the target (Figure 1). Accurate ICS evaluation at distance requires the distance correction lens powers to be in place. A routine distance refraction with binocular balance procedures can be performed, or vectographic binocular distance refraction can be used if desired. For the ICS procedure, the polarized lens bank filters must be in position. Both sides of the phoropter are left open. The patient must be cautioned to keep both eyes open...winking is not allowed. Good posture helps in assuring alignment behind the instrument, but the patient should be relaxed. The patient should act as an observer, not trying to manipulate the ICS.

Once these conditions are met, the distance ICS testing begins with the right eye acuity letters (Figure 1). The examiner scrolls in the letter block corresponding to 20/50 to 20/15. Since evaluation over time is the goal, the patient is asked to call out the 20/50 line, followed by 30 seconds of viewing the letters. During this time the patient is asked whether all the letters are there all of the time, or if any of them disappear and reappear. It is important to define "disappear" so that intermittent blurring, which is caused by accommodative fluctuation, is not counted as ICS. If the patient does not report any disappearance of letters during this time span, he is then asked to call out the letters on the 20/30 line, and the procedure outlined for the 20/50 line is repeated for this line for another 30-second period. Should he report the disappearance of letters on the 20/30 line, he is instructed to move up to the 20/40 line, and the procedure is again repeated. In this manner, determination of ICS can be carried to the 20/20 line, determining not only whether ICS is present, but also estimating the size of the suppression zone. Logically, we would expect a larger and/or more frequent suppression would be more of a disturbance.

The same procedure moves to the left eye. The examiner scrolls to the left 20/50 to 20/15 acuity block (Figure 1) and the patient is questioned about ICS for the left eye in the same manner as was carried out for the right eye.

This procedure may be difficult for some children. If there is uncertainty about the ICS diagnosis, try some of the other polarized targets available on the vectographic slide. For example, the clockdial target (Figure 3) is a favorite with children. I ask them to use their imagination and tell me what they think it looks like. Current descriptions range from a "sun" through "headlights in the fog" or a "dragonfly" to "Siamese porcupines joined at the eyeball." They are asked if any of the outer lines disappear or come back. The time taken for this exercise in imagination can allow an intermittent suppression to be seen. If the alternating OU-OS-OD "malingering" acuity lines are used in the diagnosis, care should be taken to differentiate suppressions from letter movement due to vergence fluctuations. Are the letters moving into each other, or abruptly disappearing and then reappearing?

Near ICS Testing

The (modified) Borish vectographic near card serves as the target (Figure 2). Again, the polarized lens bank filters must be in position and good posture maintained with both eyes open during all testing. The modified Borish Near Card is positioned at 40cm (16 in.) with appropriate lighting. Lens presets can be the distance lens powers, habitual near power, or if other near testing has been done, the patient's near lens powers such as crossed-cylinder powers or near retinoscopy powers.

Direct the patient's attention to the modified diamond target near the bottom of the card. I have typically preceded the near ICS testing with three sets of base-out/base-in vergences in succession to stress and fatigue the visual system. This should be diagnostically beneficial timing for eye fatigue since the observation for ICS will be next.

Once again, the diamond target has acuity letters covered by polarizers. ICS will blacken one side of the target so the letters can't be seen, unlike the target disappearances of the distance chart.

With assurances of appropriate posture and both eyes open, the patient reports changes from clear to black and back to clear. Children can raise and lower the hand on the appropriate side when one side of the diamond is suppressed. This evaluation over a similar time span of 30 to 60 seconds allows the response to be compared to published parameters for ICS diagnosis.[1,6] If the ICS lasts for only one suppression, it may not be significant, but perhaps is worth re-evaluation later. If constant suppression is reported, recheck for strabismus, check posture, and question again for ICS at distance.

Conclusions

The goal of this paper has been to address examination for intermittent central suppression over time in the context of a typical routine vision examination. These tests allow evaluation of binocular sensory vision over a significant amount of time. The doctor can also decide to include these tests in a routine doctor-administered sensorimotor evaluation.

Though constancy of binocular sensation in non-strabismics has generally been ignored in the literature, routine evaluation affords the opportunity to create the necessary body of information. If ICS is found, its intimate relationship to problems with reading and detail seeing suggests it should be treated with vision therapy. As the only documented treatment, active anti-suppression therapy must be considered the standard of care,[6,7,15,22] and generally accepted principles of medical care should define such treatment as medically necessary and appropriate. One of the next hurdles in research is measurement of spatial characteristics of this intermittent, on and off, visual sensory dysfunction.

As a final point, consider that in scientific theory the general case must reduce to the specific under appropriate conditions. The contentions of Demb et al,[8] Brecelj et al,[9] and Spinelli et al[10] suggest a picture of "dyslexia" involving a post-retinal/pre-cortical defect of the central area of vision. Strikingly similar is the clinical evidence linking ICS (a central vision defect) to reading problems (symptoms of dyslexia), as well as the suggestion that the LGN (a post-retinal/pre-cortical neurological structure) is involved. As a thought experiment, let us assume that these suggestions correctly depict the visual defect in dyslexia. If these together define an afferent central vision defect that affects the stability of detail vision, then given an appropriately aged and inexperienced child, would we expect that same afferent visual defect to affect perception and perceptual testing, given that visual perception involves various cortical areas?

How could it not?

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