

The Binocular Vision Dysfunction Pandemic

Dominick M. Maino, OD, MEd, FAAO, FCOVD-A

Editor

In 2010 there will be up to 9.3 million amblyopes and 18 million individuals with strabismus. For children under 18 years of age that means there will be more than 2 million amblyopes and millions of children with strabismus. A clinical trial to determine the prevalence of binocular vision dysfunction within the general population suggested the possibility of up to 56% or 60 million men, women and young adults with symptoms associated with a binocular vision (BV) dysfunction, 45 million (61%) with accommodative problems and 28 million (38%) demonstrating various vergence anomalies.¹

The data above was extrapolated using information from the US Census Bureau estimates of what the population will be in 2010, the estimated prevalence of amblyopia and strabismus in the general population, and a clinical trial using subjects aged 18-38 years of age.¹ But let us assume that these numbers are exaggerated by 50%. That still means there are millions of men, women and children who suffer needlessly from binocular vision disorders. There are

millions of individuals not being diagnosed. There are millions of individuals not being treated.

As I noted in a recent article:

“ ... as primary eye care professionals we do not ask the right case history questions; we do not evaluate patients using the right tests; we do not make the diagnosis; and we do not treat or refer out for treatment these frequently encountered but often ignored disorders...”

In comparison to glaucoma, cataract, age-related macular degeneration, diabetic retinopathy and dry eye syndrome; binocular vision disorders (BV) are...

more frequently encountered than these diseases and have significant negative effects on one's quality of life. ... one study revealed that the prevalence of accommodative and BV ... disorders is 9.7 times greater than the prevalence of ocular disease in children ages six months to five years old, and it's 8.5 times greater than the prevalence of ocular disease in children ages six to 18 years old.¹ ... a study of 1,679 patients between the ages of 18 and 38 showed that 56.2% presented with symptoms associated with BV dysfunction.² Although these are alarming statistics, a disconnect

exists between the high prevalence of BV disorders in the general population and the BV patients reported being evaluated by primary care optometric practices.

It's not that ocular disease is unimportant, it is... but shouldn't binocular vision anomalies also be diagnosed and treated as well? Why does this disconnect between the high incidence of BV problems and the lack of diagnosis and treatment occur? It is usually because as primary eye care professionals we do not ask the right case history questions; we do not evaluate patients using the right tests; we do not make the diagnosis; and we do not treat or refer out for treatment these frequently encountered but often ignored disorders.⁴

Correspondence regarding this editorial should be emailed to dmaino@covd.org or sent to Dominick M. Maino, OD, MEd, Illinois College of Optometry, 3241 S. Michigan Ave., Chicago, IL 60616. All statements are the author's personal opinion and may not reflect the opinions of the College of Optometrists in Vision Development, Optometry & Vision Development or any institution or organization to which the author may be affiliated. Permission to use reprints of this article must be obtained from the editor. Copyright 2010 College of Optometrists in Vision Development. OVD is indexed in the Directory of Open Access Journals. Online access is available at <http://www.covd.org>.

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The Disorders

The most commonly encountered disorders of the binocular vision system include convergence insufficiency, convergence excess, divergence insufficiency and divergence excess. Our patients' oculomotor systems may also show inaccurate and inefficiency pursuits and saccades; while the focusing problems frequently include accommodative insufficiency, excess/spasm, instability, infacility, and ill sustained accommodation.⁵

For our primary eye care colleagues, new residents, and students who might be unfamiliar with these disorders, I will briefly describe each of these conditions as noted in the American Optometric Association's Care of the Patient with Accommodative and Vergence Dysfunction Clinical Guidelines.⁵

Convergence insufficiency (CI) shows an NPC (near point of convergence) that is significantly receded from the nose, high exophoria at near, positive fusional vergences (PFV) that are reduced, and a deficit in negative relative accommodation (NRA). It is unusual to see all of the above in any single patient, but a poor NPC and high exophoria at near are almost always noted.

Convergence excess (CE) may be associated with a high ACA and has a near deviation that is 3 prism diopters more esophoric at near than at distance.

Divergence excess can be diagnosed when exophoria is greater at distance than near. These individual will have low fusional divergence amplitudes at distance as well as low AC/A ratios. Many are asymptomatic, but may report intermittent diplopia when going from a dark to a bright environment.

Divergence insufficiency (DI) Although somewhat rare, DI occurs when esophoria is greater at distance when compared to near. Many patients have low fusional divergence amplitudes at distance and reduced AC/A ratios.

Basic Exophoria and Basic Esophoria demonstrate an equal amount of deviation at both distance and near. The heterophorias may be normal but the individual will often have reduced vergence ranges and a limited zone of single clear binocular vision.

Oculomotor Dysfunction. Poor pursuit and saccadic skills are often diagnosed subjectively using a +1-4 scale with +1 indicating very poor performance and +4 the very best. More objective evaluations of the pursuits and saccades can be obtained using the Developmental Eye Movement Test.⁶

Several accommodative dysfunctions are typically present as well. These can include:

Accommodative Insufficiency. This occurs when the amplitude of accommodation is lower than expected for the patient's age and is not due to presbyopia.

Ill-sustained Accommodation. This condition is diagnosed when accommodative amplitudes are normal, but fatigue quickly occurs with repetitive demands upon the focusing system.

Accommodative Infacility. This is usually diagnosed when the accommodative system shows a deficit when changing gaze from distance to near and back again. There may also be a significant delay between the stimulus to accommodation and the resultant response.

Accommodative Excess/Spasm of Accommodation is frequently related to fatigue and may be the result of an overstimulation of the parasympathetic nervous system. It may also be referred to as the *spasm of the near reflex* which includes a disproportionate accommodative response, excessive convergence, and pupils that are miotic. Accommodative excess can also result from the use of various drugs, trauma, brain tumor, or myasthenia gravis.

Strabismus and Amblyopia

Although less frequently encountered, strabismus and amblyopia can affect anywhere from 3-6% of the population and should be routinely diagnosed and treated or referred for treatment. The most often diagnosed forms of strabismus include exotropia and esotropia. Vertical anomalies are also seen, but not as frequently. Strabismus due to trauma or disease is less often encountered, but certainly present in the patients we serve. Most primary care optometrists would probably want to refer these patients to an optometrist who specializes in strabismus treatment and is a member of such organizations as the College of Optometrists in Vision Development,⁷ a Diplomat in the American Academy of Optometry Binocular Vision, Perception and Pediatrics Section,⁸ a member of the Optometric Extension Program Foundation⁹ or a faculty member at any of our schools and colleges of optometry's optometric vision therapy services.¹⁰

Amblyopia. There are several potential etiologies of amblyopia. These include:

Form Deprivation Amblyopia occurs when light is hindered from entering the eye appropriately so that a clear, high-contrast image cannot be formed on the

retina. Congenital cataract is a frequent cause of this form of amblyopia. Form deprivation amblyopia may not be considered as truly being amblyopia by some individuals since it is of an organic/non-functional etiology.

Refractive Amblyopia. This includes anisometropic amblyopia, which is caused by uncorrected refractive error that is significantly different between the two eyes or isoametropic amblyopia whose etiology involves a fairly equal, high magnitude, uncorrected bilateral refractive error.

Strabismic Amblyopia. This is associated with an early onset constant unilateral strabismus.

Ask the Right Questions

The case history is where it all begins. I have my patients fill out a two sided history form and then review this with each individual. All too often I find that a blank left on the form should actually be filled in because the patient either missed it or did not want to answer a particular question. The patient's lack of understanding of the terminology (confusing lazy eye with strabismus for instance) can stop them from answering case history questions for fear of appearing uninformed. As you know, many of our patients also like to "test" us to see if we are as good a doctor as they expect. They may not answer all the questions because they want to find out if we are as expert as they hope we are. As a clinician, you may also want to adopt the Convergence Insufficiency Survey¹¹ and the COVD Quality of Life Survey¹² within your case history format.

Pay Attention to the Answers

I review this history with the patient, even if the patient is a child. Many times moms and dads quizzically stare at their offspring because they were not aware of the blurred vision, headaches, double vision and other vision problems reported by the child. (By the way, this goes for adults as well. Often the spouse is quite surprised by the case history results.)

I've noted that the optometry students I teach tend to do a very good job at taking a case history, and then proceed as if they never took the case history at all! We should all pay attention to the answers we

receive on our case history forms. We should ask appropriate follow-up questions. We should confirm responses/non-responses with the patient and his/her family members. I also use the case history as my guide during the examination process.

Conduct the Right Tests

It wasn't that long ago that many optometrists felt compelled to do every test ever taught to them on every patient. However these days most primary care optometrists conduct a comprehensive eye examination that is compliant with those guidelines or rules established by various third party payers, their state boards' expectations and is appropriate for their patient base. This comprehensive evaluation often will not provide enough information to determine the presence of a specific binocular vision dysfunction, learning related vision problem or the most appropriate diagnosis to determine a complete treatment plan.

I conduct a comprehensive eye examination that includes all appropriate tests that will allow me to determine if additional functional testing is needed. I then schedule the individual for that additional testing as is warranted. This assessment often includes a functional evaluation of pursuits and saccades, the Developmental Eye Movement Test, and Cover/Uncover test. If a strabismus is present I also use the Hirschberg, Angle Kappa, Krinsky and Bruckner Tests to give me information about the magnitude and direction of the deviation and the quality of fixation.

An assessment of the sensory fusion system (Worth 4 Dot, Random Dot, Wirt Dot, StereoFly) should also be completed along with determining any deficits within the motor fusion/vergence system. The motor fusion/vergence system evaluation can include the near point of convergence test, heterophoria assessment and fusional vergences at far and near. The assessment of accommodation often consists of a measurement of accommodative amplitudes, negative relative accommodation, positive relative accommodation, accommodative facility, the determination of the Accommodative Convergence/Accommodation (AC/A) ratio, and an assessment of the lag of accommodation using the MEM technique

“ ... copy or email this article to every primary care optometrist, ophthalmologist, teacher, public health specialist and therapist you know... ”

(Monocular Estimation Method). If I think that I may want to prescribe prism for my patient, I will also use fixation disparity (usually an associated heterophoria as measured by the Bernell Binocular Refraction Slide) to determine the magnitude and direction of prism required.

Make the Right Diagnosis

As most experienced optometrists will tell you, determining the right diagnosis doesn't stop after the last test is performed. You continue to observe, re-evaluate and re-assess the data frequently with each patient encounter. If you use the guidelines noted earlier in this paper, your initial diagnosis from the data obtained should be readily apparent in most instances. Experienced optometrists also know that it is seldom that all the components of a diagnosis are present within any single patient so we should use not only the science of optometric vision care, but also the art.

Using evidence based optometric care, we recognize that many of those diagnosed with binocular vision dysfunction also may have attention deficit hyperactivity disorder or vice versa.¹³ We know that children with binocular vision dysfunction can also exhibit poor academic behaviors and performance,^{14,15} and we know that after the diagnosis is made, we must determine a treatment plan that best match our patients' needs.

Determine the Best Treatment Plan

If the primary eye care provider does not feel comfortable treating these functional disorders, they should refer to an appropriate colleague who is more knowledgeable and experienced than they. (Referral sources for the primary care optometrist can be found at the websites of the American Optometric Association,¹⁶ the College of Optometrists in Vision Development,¹⁷ the American Academy of Optometry,¹⁸ and the Optometric Extension Program Foundation.¹⁹)

Of course, when treating these various binocular vision dysfunctions, we should always use the latest research to guide our treatment programs. Our internet savvy patients and their families are much more knowledgeable about these functional vision problems than ever before. We must treat and/or refer appropriately for all of these disorders or suffer the consequences associated with patient dissatisfaction which may include legal action.

Any treatment plan of a functional vision disorder usually starts with an appropriate spectacle prescription. In the United States we tend to forget about the power that a simple pair of glasses may have to improve a patient's life. The international community however has recognized that millions of individuals worldwide are significantly visually impaired because of uncorrected refractive error. Those of us who also pay attention to not only the clarity of vision but also vision function as well, know that many individuals are also functionally impaired because their spectacle prescriptions are not designed to help them with their day to day visually related tasks.

Amblyopia Treatment

Current research notes that the best treatment approach for amblyopia always starts with prescribing a pair of spectacles,^{21,22} and that glasses alone can significantly improve visual acuity. After wearing the glasses for a couple of months, if the improvement noted is not where you would like it to be, you would then start a patching regimen. We should probably not patch 24/7 because current research supports a more patient friendly schedule of patching. One study noted that "After a period of treatment with spectacles, 2 hours of daily patching combined with 1 hour of near visual activities... improves moderate to severe amblyopia..."

If patching is not a viable option, you can use the instillation of atropine ophthalmic drops in the better seeing eye. Drops are usually place into the eye over the weekend (one drop on Saturday another on Sunday). The results of using atropine closely approximate that of patching^{24,25} frequently with better patient compliance.

The one hour of near activities suggested above as a part of the treatment plan should include monocular (monocular by patching or blurring/penalization) oculomotor hand-eye and accommodation therapy procedures. You may want to prescribe one of the many optometric vision therapy computer programs available for binocular vision disorders and amblyopia as well. These include those from Home Therapy Solutions,¹⁶ Vision Builder,²⁷ and Computer Aided Vision Therapy.²⁸

If after a reasonable time period your treatment program outcomes have reached a plateau or if you are unsure as to the next step in your approach, it is probably now time for the primary eye care practitioner or those who do not offer these services to refer your

patient for a more aggressive in-office optometric vision therapy program. You should also know that the treatment of amblyopia is not just appropriate for children but also for adults. Current research in neuro and cortical plasticity strongly suggest that an active therapy program (vision scientists refer to this as perceptual learning) can show significant improvement in the visual acuity of the adult patient.

During the 2009 College of Optometrists in Vision Development meeting, respected vision scientist, Dennis Levi, OD, PhD, Dean of the optometry program at Berkeley, noted that perceptual learning (vision therapy)³⁰ is a quite successful intervention if it is intensive, engaging and appropriately challenging. He noted that this therapy boosts brain processing efficiency, decreases cortical image distortion, and is appropriate for treatment of the adult amblyope. Other researchers have stated this as well.^{31,32} As many of us know, optometric vision therapy is not just for children. We should diagnose and treat adults as well.

Strabismus Treatment

Most primary care optometrists may feel comfortable treating a strabismus that is of an intermittent nature, but not the patient with a constant unilateral, alternating or vertical deviation. I suggest referring these patients to a colleague with an active vision therapy practice. Many of our colleagues may also believe that referring for surgery is appropriate, but this may not be the case. Several studies suggest that the surgical approach is not the magic bullet some of us might believe.³³ One study noted that 13 years postoperatively no outcome was very good and only 4 were good.³⁴

Primary care optometrists also frequently encounter patients who have had multiple strabismus surgeries with varying degrees of outcome success. The intriguing story of Stereo Sue (Susan Barry, PhD) and her road to stereopsis highlights this very topic.^{35,36,37} Dr. Barry,³⁸ a Professor of Biological Sciences who specializes in stereovision and neuronal plasticity at Mount Holyoke College in Massachusetts, frequently discusses adult neuroplasticity on her Psychology Today blog³⁹ and has been featured on National Public Radio,⁴⁰ in Scientific American⁴¹ and has written a book about her experiences.⁴² Generally, she shows how adults can benefit from optometric intervention. As with amblyopia, strabismus therapy is not just for

children, but also adults. Diagnose, treat or refer as is appropriate.

Binocular Vision Dysfunction Treatment

Evidence based medicine has shown that the best and most efficacious treatment for convergence insufficiency (CI) is office based (along with home based activities) optometric vision therapy⁴³ (OVT). National Institutes of Health National Eye Institute clinical trials have also shown that this methodology of treatment is long lasting as well.⁴⁴ (For an audio/visual presentation regarding this ground breaking research go to <http://progressive.uvauld.com/pd1005/COV081/07/player.htm>)

The best, most reasonable approach with outstanding outcomes then is in-office vision therapy. If this is not possible, either because you do not offer in-office therapy or the patient's schedule does not allow participating in an active therapy program, out-of-office therapy is a reasonable alternative. This can be readily conducted utilizing the computer software resources noted earlier. With any out-of-office program it is important to monitor and manage your patients' level of compliance. I usually start them on a home therapy program, but bring them back in one week to assess how they are doing. I then reschedule them in 2 weeks and eventually, if all is going well, evaluate progress approximately every 4 weeks. If patients know you plan to keep an eye on their progress, compliance tends to be much better.

Now just because NEI clinic studies support optometric vision therapy for CI does this necessarily mean that this form of treatment is equally effective for other anomalies of the binocular vision system? The scientific basis for OVT has been firmly established⁴⁵ since 2002. There are hundreds of studies,⁴⁶ case series presentations, case reports,⁴⁷ textbooks⁴⁸ and reviews of the literature,^{49,50} on optometric vision therapy that would strongly suggest the answer to that question is a resounding YES. Additional supportive articles have been or are now being published that supports OVT not only for individuals with binocular dysfunction but for those with acquired and traumatic brain injury, autism and others with developmental, genetic, and intellectual disability who exhibit binocular anomalies as well.⁵¹⁻⁵⁷

Neuroplasticity: A Paradigm Sea Change

*Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes:
Nothing of him that doth fade
But doth suffer a sea-change
Into something rich and strange.*

From Shakespeare's *The Tempest*

A sea change is a radical, and apparently almost mystical, change. It is change of such magnitude that it alters the way we think and what we do in a sweeping, far ranging, mind expanding, mega-behavior transformative fashion. The research into neuro and cortical plasticity offers optometry an opportunity to dive into this magnificent "sea-change" ocean of new ideas.⁵⁸ This research and these new ideas strongly support our management of binocular vision dysfunction and optometric vision therapy for our patients of all ages.^{27,59-61}

And finally as Gilbert et al notes, "The visual cortex retains the capacity for experience-dependent changes, or plasticity, of cortical function and cortical circuitry, throughout life."⁶² We should use this knowledge in our approach to providing primary eye care. We must ride this *sea-change* wave to its very crest for the benefit of all our patients. It is time for primary care optometry to diagnose, treat or refer those millions of individuals suffering from binocular vision dysfunction. It is inexcusable and perhaps bordering on malpractice not to do so. Since this article was written for a much wider audience than the typical readership of *Optometry & Vision Development*, I would suggest you copy or email this article to every primary care optometrist, ophthalmologist, teacher, public health specialist and therapist you know. Put links to this article on your websites, blogs, and digital social networking sites to this article. Hand copies out to your patients. Shouldn't all be aware of the benefits that they can achieve through proper diagnosis and treatment? Shouldn't they be a part of stopping this pandemic of undiagnosed and untreated binocular vision disorders? The short, most appropriate answer to these questions is, YES.

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