Article • A Case Series in Optometric Management of Diverse Vertical Deviations

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ABSTRACT

Background: Vertical deviations present in diverse patient populations with a multitude of puzzling symptoms and complaints. Many patients with vertical deviations have visited numerous doctors looking for an explanation for their symptoms of dizziness, headaches, motion sickness, and double vision. Vertical deviations may be apparent in the clinical optometric exam sequence, but at other times, additional testing must be performed to uncover a vertical heterophoria, including fixation disparity, vertical vergences, a period of diagnostic occlusion, or Maddox rod.

Case Report: Three case reports are reviewed with diverse presentations of vertical deviations. The first case report outlines Patient A, a 51-year-old female who presented with dizziness along with a latent hyperphoria that was not apparent on the initial clinical examination. The second case report outlines Patient B, a 52-year-old female who presented with a longstanding large-angle vertical strabismus with strabismic amblyopia in the right eye. The third case report outlines Patient C, a 61-year-old female who presented with intermittent vertical diplopia following a cerebrovascular accident. The three cases all underwent vision therapy or vision therapy in combination with prismatic correction, and all three cases experienced symptom reduction following treatment with optometric vision rehabilitation.

Conclusion: Vision therapy alone, or vision therapy in combination with prism lenses, was an effective treatment option for reducing symptoms in a diverse series of patients with vertical deviations.

Keywords: contact lenses, hyperphoria, vertical heterophoria, vertical prism, vertical strabismus, vision therapy, visual vestibular integration

Introduction

Vertical deviations are common, with an estimated prevalence of 7-52%.[1,2] Scheiman and Wick estimate that between 15 and 20% of all patients are symptomatic for vertical ocular misalignments.[3] Vertical heterophorias can cause a constellation of troubling symptoms, including dizziness, nausea, lightheadedness, sensitivity to light, neck and shoulder pain, headaches, and reading difficulty.[4-7] Other symptoms include vertical diplopia, motion sickness,[8] or even feeling anxious when in crowds or large department stores.[9] It is important to identify even small vertical deviations when symptomatic due to the quality-of-life concerns that can arise from unaddressed vertical deviations. Vision therapy or a combination of vision therapy and prismatic correction have been shown to be the most effective treatment options for patients with vertical deviations.[1] An increase in vertical fusion ranges and a lasting decreased slope on the forced duction vertical fixation disparity curve have been demonstrated following vertical vergence vision training.[8] Vertical vergence therapy can be addressed in

Table 1. Presenting Exam Findings Case # 1*

Test	Clinical Findings
Distance VA with habitual CLs	OD: 20/20, OS: 20/20-2, OU: 20/20
Current Rx	Acuvue Oasys OD: -10.50 DS, OS: -11.00 DS
Distance vergences	BI: x/10/6 BO: x/30/16
Near vergences, without add	BI: 6/14/12 BO: 14/45/18
Distance cover test	Orthophoria horizontal and vertical
Near cover test, without add	6 EP', orthophoria vertical
ReadAlyzer	Increased fixation duration (0.37 seconds)
Physical observation	Broad unsteady gait noted

***Measured by a different attending OD**

vision therapy directly or indirectly by working horizontal ranges, using partial compensating prism or stress prism, and addressing co-existing poor eye movements if present.[3] Vertical strabismus will be readily apparent upon traditional binocular vision testing. In other cases, a small vertical phoria may not be apparent on the clinical examination, but the patient may show multiple signs and symptoms of a vertical deviation. In these cases, more in-depth testing may be required to find a small or latent hyperphoria. Once a vertical deviation has been successfully diagnosed, the clinician must determine the most appropriate treatment plan for the patient, which may include vertical prism optical correction, vision therapy, or vertical prism in conjunction with vision therapy. This decision is based on clinical findings, as well as through a discussion with the patient regarding their motivation for pursing vision therapy and their lifestyle and occupational needs. It is also based on how best to manage the troubling symptoms that often accompany vertical deviations.

Case #1

Patient A, a 51-year-old Caucasian female, presented with complaints of feeling as if she was falling forward and to the left for the past eighteen months. These symptoms occurred frequently throughout the day, although they did not occur every day. She reported having a few days of symptoms followed by a few days without symptoms. Triggers included standing or sitting still, busy surroundings, patterned wallpaper and carpet, crowded rooms, and bright lights. She reported that she did not enjoy reading due to having to focus very hard. She also reported blurred vision OS with correction. She further reported having headaches in the occipital region that were described as a dull ache. Her medical history was positive for seasonal allergies, sinus congestion, tension in the neck and shoulders, and prior situational depression. Her ocular history was unremarkable.

Her prior workup for the current condition included a CT scan, an MRI, blood work, cardiac testing, and VOR testing. She had also undergone ENT, neurology, and ophthalmology evaluations. All tests were reported as negative. She was diagnosed with migraines by her neurologist and was started on a beta blocker, which subjectively did not improve symptoms. She was referred for physical therapy to improve balance and vestibular/occupational therapy to focus on vestibular integration for dizziness. Her occupational therapist suggested that she be evaluated for potential vision therapy. She presented to the vision therapy service for a vision therapy evaluation (Table 1) and was diagnosed with saccadic dysfunction due to significantly increased fixation duration recorded on the ReadAlyzer. No other binocular vision dysfunctions were found at the initial vision therapy examination. All testing was performed through the patient's habitual contact lenses. She had a pair of +1.75 OTC reading glasses but reported not using them due to her eyes not feeling like they were working well together with the glasses. The near visual acuity through the habitual contact lenses was 20/20-3 OU. She was enrolled in weekly vision therapy sessions to improve symptoms.

In therapy, Patient A stated that her left eye felt "shimmery" and that her eyes were not working very well together. On observation,

Table 2. Sample Vision Therapy Program for Visual-Vestibular Integration and Vertical Phorias

Area of Emphasis	• Vision Therapy Activity
Vertical vergence	• VTS4 multiple-choice vergences –vertical sequence • Visicare vertical fusion cards • Split prism Marsden ball • Brock string • Vertical fusion target set • Barrel card • Vectograms using horizontal and vertical protocol
Vestibular integration	• Wolff wand saccades on balance board • Incorporating head and body movement into therapy activities • Hart chart saccades on 3 walls, turning the head to view each chart • Greenwald eye movements
Pursuits	• AN star • Pegboard rotator • Eye control • Coin circles
Saccades	• Near-far Hart chart • Hart chart column jumping • Ann Arbor Michigan tracking • Dotting Os

she had a variable head tilt, so a 1$^{\Delta}$ BD prism was held in front of her left eye, which improved symptoms. When the orientation of the prism was reversed (1$^{\Delta}$ BU OS), the symptoms became noticeably worse. The patient was given a 1$^{\Delta}$ loose prism to take home for a one-week trial. She reported that her symptoms improved significantly in different settings using the loose prism. It was decided to incorporate prism into her refractive correction.

The patient preferred to remain in soft contact lenses as her primary vision correction due to her highly myopic prescription. X-Cel offers base-down prism in soft spherical contact lenses in 0.5 diopter steps from 1.5 to 2.0 diopters. A pair of custom X-Cel FlexLens soft contact lenses were fitted: -9.50 DS OD and -10.50 DS/1.5$^{\Delta}$ BD OS. The lens availability is limited to the following prism powers: 1.5$^{\Delta}$ BD and 2.0$^{\Delta}$ BD in spherical powers, so a 1.5$^{\Delta}$ BD prism power was selected as the most appropriate choice for the patient. Initial improvement in symptoms was reported upon the fitting. The recommended care system was Clear Care (Alcon), and the recommended

Table 3. Case #1 Vision Therapy Progress Exam Findings

Test	Clinical Findings
Distance Von Graefe phoria, without prism	2 exophoria, 1 left hyper
Sheedy Disparometer, without prism	Ortho horizontal, ortho to 1 left hyper vertical
Wesson Card, without prism	Ortho horizontal and vertical
Distance cover test, without prism	Ortho horizontal and vertical
Near cover test, without prism	3 exophoria, ortho vertical
Distance verg, with vertical prism CL	BI: 8/9/4 BO: 10/22/16
Near verg with vertical prism CL	BI: 10/24/20 BO: 14/22/12
Vertical verg, with vertical prism CL	OD: 3/1.5 BD, 2/1 BU OS: 2/1 BD, 3/2 BU
Vertical verg, without vertical prism CL	OD: 4/2 BD, 2/1 BU OS: 2.5/2 BD, 2.5/1 BU
Physical observation	Steady gait, no imbalance when walking

replacement schedule was quarterly. Upon further review, vertical prism ballasted soft contact lenses are also available 0.5$^{\Delta}$ BD to 4.0$^{\Delta}$ BD in 0.1$^{\Delta}$ diopter steps in spherical, toric, or multifocal powers from SpecialEyes as an additional option for patients needing prism correction who desire to remain in soft contact lenses.

Vision therapy for a vertical deviation with coexisting dizziness should include visual-vestibular integration as well as vertical fusion training to address all symptomatic areas (Table 2). There are several approaches to incorporating vestibular input into vision therapy effectively, all of which involve getting the head moving through space during traditional vision therapy activities. For example, one may incorporate vestibular therapy into a wall saccades activity by placing the letter charts on three different walls of the room, each ninety degrees apart. The patient can call out letters from each modified Hart chart in sequence, using head movements to view each chart. In addition, the Greenwald Eye Movements technique is an effective way to incorporate vestibular integration. This activity involves tracking a swinging Mardsen ball first with the eyes only, then with the head only, and finally with the head tilted fifty-five degrees backward with the eyes and head only.

Table 4. Clinical Examination Findings Case #2

Test	Initial Clinical Finding	VT Progress Exam
Distance VA	OD: 20/30-2, OS: 20/20, OU: 20/20	OD: 20/30+2, OS: 20/20, OU: 20/20
Distance cover test	25Δ CRHT	16Δ CRHT
Near cover test	15Δ CRHT, 5Δ CRXT component	3Δ IRHT, 4Δ IRXT component 50% frequency
Randot stereopsis	Suppression OD, (-)forms	(+)600 sec forms, (-)suppression
Worth 4-dot, distance	Suppression OD light and dark	Suppression OD in light, vertical diplopia in dark
Worth 4-dot, near	Suppression OD in light, vertical diplopia in dark	Fusion in light, fusion 50% in dark
Parks 3-step test	Right superior oblique weakness	Not tested

After one month of using the contact lens with prism correction, Patient A returned to all of her daily living activities with her previous symptoms resolved. She graduated from a program of vision therapy based on the results of a progress exam and continued daily wear of the vertical prism contact lenses to manage symptoms (Table 3). On follow-up, when the prism contact lens was removed, the patient reported an immediate feeling of dizziness and imbalance. She felt as though she was in a cave and things around her were moving without the prism. Objectively, she appeared to be less balanced, with a broader stance when walking, when the prism was removed. Upon a three-month follow-up after vision therapy graduation, Patient A was happy with the comfort and clarity of her vision, and her symptoms of dizziness remained at bay. She continued to wear the prism-ballasted contact lens in the left eye, and symptoms remained relieved upon a one-year follow-up. A glasses prescription was written with vertical prism as a backup to the contact lenses.

Case #2

Patient B, a 52-year-old Caucasian female, presented to the clinic complaining that her right eye had been drifting upward for as long as she could remember. She reported failing a vision screening when in kindergarten and remembered failing a binocular vision test as a part of testing before beginning her current career as a social worker over 20 years prior. Double vision was not present, indicating a longstanding cortical suppression of the right eye. There was a longstanding reported concurrent strabismic amblyopia in the right eye. She complained of poor depth perception and reduced vision in the right eye. She felt as though her right eye was "floating" at times, and it was most noticeable when she was tired or when she drove at night. She also had a desire to have the experience of binocular vision.

Patient B's initial vision therapy evaluation revealed a constant right hypertropia (25^{Δ} right hypertropia at distance, 15^{Δ} right hypertropia at near, with a 5^{Δ} right exotropia component) with constant deep suppression of the right eye at distance and near (Table 4). Her saccadic eye movements were within age norms using the Developmental Eye Movement Test. A Parks three-step test revealed a right superior oblique underaction. The patient presented with a habitual right head tilt, which further decompensated the hypertropia and acted as a possible aid in cortical suppression of vision in the right eye. The most likely differential diagnosis was an early-decompensated congenital fourth nerve palsy. The patient was enrolled in weekly vision therapy with a guarded prognosis and was educated on potential positive and negative outcomes of initiating vision therapy, including inducing diplopia.

Therapy was initiated, beginning with a regimen of antisuppression and monocular skills techniques, followed by a transition into monocular-fixation-in-a-binocular-field (MFBF) and fusion training therapies (Table 5). Upon a progress exam after eight sessions of vision therapy, Patient B was able to obtain global Randot stereopsis (600 seconds of arc),

Table 5. Sample Vision Therapy Activities for Vertical Strabismus

Sample Vision Therapy Activities for Vertical Strabismus	
Antisuppression	• Squinchel • Mirror overlap • Dissociated Marsden ball • Luster activities • Amblyoscope first-degree fusion targets • Van Orden stars
Monocular Fixation in a Binocular Field	• Sherman playing cards • Amblyomazes • SVI red/blue activities • MFBF matching game
Fusion	• See three cats • See three coins • Quoits vectogram • Amblyoscope second-degree fusion targets • Flat fusion activities on VTS4 program • Cheiroscopic tracings • Brock string

but she was unable to appreciate depth on the Wirt circles. She achieved second-degree fusion on the Worth four-dot test in both light and dark at near, but not at distance. During therapy, she was able to perceive stereopsis on the Quoits vectogram at near, with correct perception of SILO. Second- and third-degree fusion was achieved out to a distance of approximately 3 feet away, but not at distance. The patient remediated the decompensating head tilt throughout the course of therapy but preferred not to tilt her head in the compensating direction.

Patient B reported intermittent and transient vertical double vision that was alleviated by tilting her head to the right or by blinking. She further reported that she remembered double vision happening before vision therapy but that she was made more aware of the occurrence through her experience in therapy. The patient reported that faces and her hands appeared different than previously and that they now had different contours and depth to them. Patient B elected to self-discontinue vision therapy after fifteen sessions. She achieved her vision therapy goal of experiencing binocular vision with gross/peripheral stereopsis for the first time.

Superior oblique palsies, whether congenital or acquired, lead to non-comitant vertical deviations, which can become more comitant over time due to the spread of comitance. Superior oblique palsies frequently demonstrate a different magnitude of hyper deviation in the distance versus near, as was the case for this patient. Ohtsuki et al. studied vergence adaptation in 84 patients with superior oblique palsies and found that 43% of individuals studied had a difference in magnitude distance versus near of greater than five prism diopters when controlling for avoiding downgaze viewing during the near cover test.[10] Vision therapy is beneficial when addressing non-comitant vertical deviations and those that differ in magnitude in distance versus near.[1] Starting with vision therapy rather than prism in these cases of longstanding or congenital vertical strabismus can reduce the amount of prism eventually needed in a glasses prescription. Binocular fusion and MFBF activities are started at the viewing distance or angle of least magnitude until fusion is achieved and are extended over time into the areas of gaze where the magnitude is larger in a gradual or stepwise fashion. An example would be using the Brock string in multiple fields of gaze or using vectograms on a projector and working on fusion as the patient is taking small steps back and forth in front of the projector screen.

Case #3

Patient C, a 60-year-old Caucasian female, was referred for a vision therapy evaluation by the primary care service in January 2017. She suffered a right thalamic cerebrovascular infarct on February 12, 2016, which was followed by three transient ischemic attacks in June, August, and October of 2016. Following the stroke, Patient C complained of fluctuating vision and double vision oriented diagonally. Thalamic infarcts, while uncommon, are known to cause vertical gaze palsies and vertical ocular misalignments.[11-13] Her ocular history was significant for trace nuclear cataracts in both eyes, chronic dry eye syndrome, mid-peripheral

Table 6. Case #3 Initial Clinical Examination Findings

Test	Clinical Findings
Entering distance VA	OD: 20/30-1, OS: 20/25-1, OU: 20/20-3
Best-corrected distance VA	OD: 20/25, OS: 20/20, OU: 20/20
Distance cover test	2^{Δ} left hyperphoria
Near Cover Test	4^{Δ} left hyperphoria, 3^{Δ} esophoria
Maddox rod	6^{Δ} left hyperphoria measured at near in primary gaze
Distance Worth 4-dot	Diplopia in light and dark
Near Worth 4-dot	Fusion in light and dark

retinal pigmentary changes, and a longstanding history of bilateral visual field constriction. A previous electroretinogram revealed normal latencies and amplitudes under photopic and scotopic conditions, indicating no pathology involving the rods, cones, or ganglion cells of the retina leading to visual field loss. A B-scan ultrasound revealed hyperreflectance at the optic nerve on high and low gain settings, indicative of buried optic nerve drusen with associated visual field loss.

Her medical history was significant for hypertension, recurrent shingles on her arms, asthma, and a reduced immune system secondary to low cortisol levels. She had a history of ovarian cancer, back surgery, and shoulder surgery. She had residual left-sided weakness following the initial stroke in February 2016.

At the vision therapy evaluation, Patient C complained of intermittent diagonal double vision, which was worst in the evenings and when performing near work. She had difficulty reading and performing computer work for the past year after her stroke. She also complained of double vision when watching television. Her activities of daily living were severely impacted by frequent double vision. Her initial vision therapy examination (Table 6) revealed a comitant 4^{Δ} left hyperphoria through her habitual glasses with a 3^{Δ} esophoria component at near measured via cover test. Her distance cover test revealed a 2^{Δ} left hyperphoria. The esophoria at near dissipated when the hyperphoria was neutralized with prism first.

The visual midline shift test and the line cancellation test revealed no neurological neglect. The Clockdial test was performed accurately, with the anchors 12, 3, 6, and 9 placed first. A Goldmann visual field revealed generalized visual field constriction that did not respect the horizontal or vertical midline indicative of neurological field loss. The King-Devick test revealed below-average saccadic eye movement performance.

Two prism diopters of base-down prism over the left eye was trialed in office, which led to an elimination of diplopia and better feelings of balance and clarity while walking around. Fresnel prism was dispensed for a two-week trial, which alleviated symptoms and led to increased performance of near tasks. A glasses prescription was finalized with 2^{Δ} BD over the left eye.

At the three-month progress exam, Patient C reported that the glasses had largely eliminated her symptoms but that she was still experiencing double vision twice per day for one to two minutes at a time when reading. She was able to remove her glasses and blink to re-fuse when experiencing double vision. Cover test over her habitual glasses with prism revealed orthophoria at distance and near. Maddox rod testing over her glasses revealed an additional 2^{Δ} of left hyperphoria in all fields of gaze except upgaze, where there was a 3^{Δ} disparity. With the prism, her vertical vergences were 5/3 BU and 5/3 BD OD.

Vision therapy was recommended at the progress exam to increase control of fusion and to increase fusional vergence ranges, as well as to address the saccadic eye movement dysfunction. The patient enrolled in a program of vision therapy. Vision therapy was estimated to last for twenty to thirty sessions in total. Activities planned would work on horizontal and vertical fusional ranges and oculomotor skills. Examples of fusional techniques include vectograms, Brock string, and the Vodnoy aperture rule. Oculomotor activities include

Hart chart, saccadic activities, and Ann Arbor (Michigan) tracking. Vertical fusion ranges can be addressed using vertical prism dips and by incorporating vertical prism into other activities, such as the horizontal vectograms. Vision therapy was initiated under another provider; at the time of writing, the patient had undergone nineteen vision therapy sessions. Goals for vision therapy included gaining better control of fusion, increasing vertical fusion ranges, and stabilizing rather than increasing the vertical prism incorporated into the patient's habitual glasses prescription. The patient's goals for vision therapy included increasing reading comfort and reducing the incidence of double vision.

Discussion

Vertical deviations are not uncommon in an optometric practice. Vertical deviations have a wide variety of clinical presentations, including latent hyperphorias not apparent on initial clinical examination, decompensated longstanding hyper deviations, vertical strabismus, or vertical phorias or tropias of a neurological origin, such as those presenting after a stroke. Vertical heterophoria should be included in the differential diagnosis when a patient presents with vague complaints of dizziness, headaches, and imbalanced feelings. A careful case history should be taken from a patient with a suspected vertical deviation with attention to any medications taken, any prior head or eye trauma, previous eye surgeries, previous head and neck surgeries, and any prior treatments for visual conditions. Physical observations, such as a head tilt or unusual head posture, should be noted. Testing for a suspected vertical deviation when no vertical movement is present on a primary gaze cover test should include Maddox rod, Von Graefe phorias, vertical Von Graefe vergences, and cover testing in nine fields of gaze. When no objective motion is present on the cover test, subjective phi motion can be assessed as an additional way to evaluate a vertical phoria.[7] Further testing may include assessing the associated phoria or the fixation disparity by using the Sheedy disparometer, the Wesson card, or the Mallet box.[5]

Small vertical deviations are easy to overlook as a part of the clinical exam sequence, especially when no vertical movement is seen on the alternating cover test. In many cases, further testing is not pursued due to a lack of clinical findings to support it. With Patient A, therapy was initiated based on diagnosed saccadic oculomotor dysfunction and associated visual symptoms. A few sessions into therapy, it was noted that the patient had a variable head tilt and reported that her left eye felt "shimmery." The signs and symptoms of the small vertical phoria were revealed during the course of therapy, which then prompted further investigation. Prism was then prescribed the form of a vertical prism-ballasted spherical soft contact lens in addition to therapy to improve symptoms. Patient B presented with a longstanding superior oblique palsy, leading to a relatively large angle noncomitant vertical strabismus. In this case, the author preferred to start with vision therapy and consider prescribing prism later, whether Fresnel or ground-in, if still indicated. Starting with therapy in large-angle vertical strabismus can reduce the amount of vertical prism needed in an initial prism prescription. The author elected to start with prism alone in Patient C because of the frequent vertical diplopia she was experiencing. The vertical diplopia was decreasing her day-to-day quality of life and needed to be addressed as soon as possible. The prism prescribed greatly reduced symptoms but did not fully eliminate the diplopia experienced. A discussion took place with the patient regarding her options of increasing the prism prescription versus enrolling in vision therapy to increase control of eye movements and fusion upon follow-up. The patient and the author made a joint decision to enroll in vision therapy.

Conclusion

Vision therapy alone or vision therapy in combination with vertical prism incorporated into optical correction, whether glasses or contact lenses, is an effective treatment option for managing a wide variety of patients with vertical deviations. Individuals who have undiagnosed hyperphoria can be highly symptomatic, even with subtle clinical findings. Correcting vertical deviations with prism, vision therapy, or a combination of the two treatment methods can greatly improve quality of life.

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