Article ▸ Vision Therapy Management for Intermittent Hypertropia with Exotropia

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ABSTRACT

Background: Symptomatic vertical deviations are commonly managed with vertical prism in spectacles because it may be difficult to improve vertical vergence with vision therapy (VT). This case demonstrates the use of vertical prism for immediate relief of symptoms, followed by VT and gradual removal of all prism from the spectacles. The patient remains asymptomatic following treatment.

Case Report: A 12-year-old girl with longstanding oblique diplopia and head tilt desired relief of symptoms. She had never worn prism spectacles, as her mother believed prism would worsen her condition. Visual acuity was 20/20 in each eye through moderate myopic prescription. Cover test showed 10^{Δ} intermittent alternating exotropia with 6^{Δ} left hypertropia at far and near, present about 80% of the time. Worth 4-dot testing revealed diplopia at 6 feet and intermittent fusion at 16 inches. Stereopsis was 50" with (+) random dot forms. Parks 3-step testing revealed mild left superior oblique under-action. Associated vertical phorias in primary gaze were 2^{Δ} base down (BD) OS. The patient preferred 3^{Δ} BD OS subjectively for comfortable fusion without head tilt. Spectacles with her myopic correction and 1.5^{Δ} base up (BU) OD/1.5^{Δ} BD OS ground-in prism were prescribed, along with VT. The VT program lasted six months and included accommodative and horizontal vergence techniques at near and far, 1-4^{Δ} BU OS "stress" prism during horizontal vergence VT, and vertical vergence techniques. Spectacle prism was cut to 1.5^{Δ} (total) after four months of VT. At her next yearly examination, the prism was eliminated. She has remained with associated vertical phoria values of zero and excellent control of her hyper- and exodeviations.

Conclusion: Vision therapy for vertical deviations may not be the primary treatment option due to the multitude of challenges it poses for many patients and clinicians. This report details a highly motivated patient who was successfully managed with VT and no longer needs prism compensation. Even though treatment may be lengthy and demanding for all involved parties, VT remains a viable, and sometimes the best, treatment option for long-term success.

Keywords: Diplopia, exotropia, hypertropia, prism, vergence, vertical strabismus, vision therapy

Introduction

Patients with symptomatic primary vertical deviations, with or without a horizontal component, are commonly managed with vertical prism in spectacles as the preferred treatment.[1] The term "primary vertical deviation" means that a deviation is present whether or not the patient is fusing. During fusion, such a patient manifests a vertical fixation disparity. Prescribing the associated phoria (the amount of prism that eliminates this vertical fixation disparity) has been shown to reduce symptoms effectively.[2] Often this amount of prism is less than the value that would fully neutralize the cover test; thus the prism is termed "relieving prism" as opposed to "neutralizing prism." Another method of determining a relieving prism prescription is to find the minimum prism that eliminates the patient's diplopia subjectively (fusion prism), while the patient views an isolated target.[3] In either case, advantages of prescribing relieving prism compared to neutralizing prism include reduced weight and improved cosmetic appearance of spectacles. Additionally, a relieving prism prescription reduces the likelihood of overcorrecting the deviation and leaves the patient with a deviation to compensate. A consequence of using relieving prism is that some patient effort is required to maintain fusion, a type of passive vision therapy (VT). If management using vertical prism proves inadequate, an active program of VT can be used in addition to, or in place of, prism.[1] However, VT for vertical deviations may be challenging and require high patient motivation.

Robertson and Kuhn[4] reported on three adult patients with vertical deviations of up to 5^{Δ}. All underwent VT, which included vertical vergence training, and all achieved some reduction in symptoms.[4] Cooper[5] reported on four adult patients with vertical deviations ranging from 12-20^{Δ}. He treated the patients with the minimum vertical prism to eliminate diplopia, along with horizontal vergence therapy. Spectacle prism was gradually reduced while horizontal therapy continued. These patients achieved significant reduction of symptoms and in some cases only needed to wear a small amount of prism part-time after completing treatment.[5] Wick[6] reported on two adult patients, one having a 4^{Δ} hyperphoria and the other having a 7.5^{Δ} hyperphoria. Both wore a small

Table 1: Pertinent Examination Findings, Pre-VT.

Best-corrected distance and near Snellen acuities	OD 20/20, OS 20/20
Dry and cycloplegic refraction (identical)	OD -4.00 sph. OS -3.25 -0.50 x 180
Cover test (aided, far and near)	10^{Δ} IXT with 6^{Δ} ILHT, frequency ~80%
NPC	5 inch break/10 inch recovery, (+) diplopia
Stereopsis (Randot)	50 sec. arc, (+) forms
Worth 4-dot	Diplopia at 6 feet, intermittent fusion at 16 inches
Horizontal vergences (near)	BI x/6/2, BO x/4/2
Vertical vergences	Left supra 10/3 far, 8/1 near; Left infra 5/1 far, 3/1 near
Parks 3-step test	Mild LSO underaction
Vertical associated phoria (primary gaze, far and near)	2^{Δ} BD OS, but could not hold fusion
Prism subjectively preferred for fusion	3^{Δ} BD OS relieved all symptoms, far and near
Accommodative amplitudes (push-up, in diopters)	9 OD, 8.3 OS
Pursuits and saccades	4+ OD, OS
Extraocular muscles	Full range of motion
Confrontation visual fields	Full OD/OS
Color vision (Ishihara)	8/8 plates OD/OS
Pupils	Equal, round, reactive, no afferent defect
Anterior segments	Healthy OU
Intraocular pressures	13 mm Hg OU
Dilated fundus examination	Healthy OU

IXT: intermittent exotropia; ILHT: intermittent left hypertropia; LSO: left superior oblique

Table 2: Vision Therapy Activities

Accommodation	+/- lens flippers
	Minus lens rock (far target)
	Minus lens voluntary clear/blur/clear
Horizontal vergence	Brock string (bead push-up, jumps, and imaginary "bug on string" for voluntary vergence)
	Barrel card
	Vectograms (near, far, with BIM/BOP)
	Computerized vergence with random dot targets
	Eccentric circles (near, far, with versions)
	Aperture Rule Trainer
	Cover/uncover of an eye, noting diplopia, then fusing
Vertical vergence	Vectograms BO and BI through stress prism (1-4^{Δ} BU OS)
	Eccentric circles BO (smooth and jump) with vertical separation
	Aperture Rule BO and BI with stress prism (BU OS) and loose vertical prism jumps
	Jump vergence using loose prisms (1-4^{Δ} BU OS) with distance target

BIM/BOP: base-in prism and minus lenses alternating with base-out prism and plus lenses

amount of spectacle prism at the outset of a course of both horizontal and vertical vergence therapy. The patient with the larger deviation was successful in eliminating the need for prism wear and in having her symptoms alleviated, and the patient with the smaller deviation continued to use her prism correction only for reading. In the present case we demonstrate the use of vertical prism for immediate relief of symptoms, followed by VT for the intermittent hypertropia and exotropia, and gradual removal of all prism from the spectacle prescription. The patient remains asymptomatic following treatment.

Case Report

A healthy 12-year-old girl presented to the Pediatrics/Binocular Vision Service of the Illinois Eye Institute with longstanding oblique diplopia and head tilt. She experienced headaches approximately twice a week after brief periods of reading. She wore prescription lenses for myopia but had no history of prism wear, as her mother was concerned that prism would worsen her condition. She had attempted VT one year prior for only three weeks, but was unable to continue at that time. She was taking no medications. Pertinent examination results are shown in Table 1. Associated phoria testing was performed using the Bernell Near Point Analysis Slide and Fixation Disparity at Far Slide.[a] The associated phoria measured 2^{Δ} base-down (BD) OS, but the patient had difficulty maintaining fusion through this amount of prism. Subjective prism to eliminate diplopia was determined instead, resulting in a value of 3^{Δ} BD OS for both distance and near viewing.

The patient was diagnosed with primary intermittent left hypertropia (ILHT) and basic intermittent exotropia (IXT) (equal angle near and far). The vertical deviation was mildly noncomitant due to the longstanding left superior oblique muscle underaction. This diagnosis was based on the Parks 3-step test; torsion of the eye was not evaluated. The larger than average total vertical vergence amplitude suggested a longstanding muscle palsy. A study by Rutstein and Corliss[7] showed that the longer the duration of superior oblique palsy, the larger the amplitudes of supra- and infravergence. In addition, the patient was diagnosed with myopia, slight astigmatism in the left eye, and accommodative insufficiency (based on push-up accommodative amplitudes below the minimum of 12 D calculated for her age).[1]

Because the patient was very symptomatic but also motivated to undergo VT, the minimum prism to eliminate

Table 3: Patient Progress

Prior to prism Rx and VT	10^{Δ} IXT with 6^{Δ} ILHT far and near, 80% Vertical associated phorias: 2Δ BD OS far/near
After 3 months of VT (wearing a total of 3^{Δ} BD OS)	10^{Δ} exophoria with 3^{Δ} left hyperphoria far and near
After 4 months of VT (through a total of 1.5^{Δ} BD OS)	No Sx; 8^{Δ} IXT/6^{Δ} ILHT far and near, 10% Far BO x/25/20, near BO x/>45 Vertical vergences: left supra 9/6 far, 9/7 near; left infra 3/1 far,1/-1 near Accommodative amplitudes: 14.5 D OD/OS Accommodative facility (+/-2.00): 16 cycles/minute OU Vertical associated phorias: 2^{Δ} BD OS far, 0^{Δ} near
At completion of VT (6 months total, still wearing 1.5Δ BD OS)	No Sx; 6^{Δ} IXT/6^{Δ} ILHT at far 10%; 6^{Δ} exophoria with 6^{Δ} left hyperphoria at near Far BI x/8/6, BO x/>45/45 Near BI x/20/18, BO x/>45/45
2 months post-VT (tested through 1.5^{Δ} BD OS)	No Sx; stable findings from last visit Vertical associated phorias: 0^{Δ} BD OS far and near
5 months post-VT (tested through no prism)	No Sx; rare 8^{Δ} IXT/6^{Δ} ILHT far & near when dissociated, immediate recovery Vertical associated phorias: 0^{Δ} BD OS far and near Subjective refraction of -4.00 sph. OU was prescribed, without prism
19 months post-VT (wearing no prism)	No Sx; stable findings

diplopia was prescribed: 1.5^{Δ} BU OD and 1.5^{Δ} BD OS, along with full refractive correction. It was understood that the patient and her mother did not want her to wear prism long-term, but they agreed to use prism to alleviate diplopia until her visual skills were sufficient to achieve comfortable fusion without prism. She was comfortable wearing the prism and had no headaches or diplopia unless she removed the glasses. Some authors recommend prescribing more of the prism for the eye with the motility limitation in noncomitant strabismus;[8] however, this patient's noncomitancy was very mild and she showed no motility limitation. Therefore, prism was split equally between the two eyes. Vertical prism also made it easier for her to perform horizontal vergence therapy.[1,5] Later, the patient was able to perform vertical therapy as well.

The patient underwent a total of 17 VT visits over a period of 6 months, as her schedule did not permit weekly office visits. Compliance with requested home VT was excellent. Table 2 lists the VT techniques employed in the program in the approximate order they were used during in-office VT. In addition, the lens techniques, Brock string, and all variations of eccentric circles activities were assigned for home use sequentially during the program. The VT techniques were performed in a customary manner as described elsewhere.[1] After the patient had developed better horizontal fusion ranges while wearing her spectacles with relieving prism, specific vertical fusion demands were incorporated into the program. Vertical demands were increased in several ways: smooth vergence (e.g., slow vertical separation of chiastopically fused eccentric circles cards); jump vergence (e.g., loose vertical prism placed and then removed over one eye, requiring the patient quickly to fuse the target each time); and stress (isometric) vergence (e.g., fusing Vectograms with horizontal separation while viewing continuously through vertical prism with its base opposite to the relieving prism in her spectacles).[1]

Table 3 demonstrates the patient's progress over time. After four months of VT, her skills had improved enough that she could have the amount of prism reduced to only 1.5^{Δ} BD OS. To keep the cost lower, only her right spectacle lens was remade without prism. In-office VT continued for two more months, at which time she reported no symptoms and showed IXT/ILHT 10% of the time and only at far during the cover test. In-office VT was terminated, and home maintenance continued with large and small eccentric circles. The associated phoria values (measured with head straight in each case) decreased gradually, reaching zero (measured without spectacle prism) five months after in-office VT concluded. At that time, a new spectacle prescription without prism was issued. The patient has remained comfortable since that time, occasionally noting brief diplopia when tired and easily regaining fusion. At her most recent comprehensive examination (19 months after completing in-office VT), she reported distance blur due to a slight increase in myopia, and was fit with spherical soft contact lenses (also without prism).

Discussion

Following a period of six months of active VT and five additional months of follow-up, this patient achieved her goal of relief from her visual symptoms without the use of prism to compensate for her vertical deviation. Excellent compliance with VT was a key factor in her success. Although the final outcome was excellent, it was important to improve the patient's comfort and binocular function initially with prism spectacles. This prism prescription was based on the minimum amount to relieve diplopia (fusion prism, 3^{Δ} BD OS total), because the associated phoria value (2^{Δ} BD OS) apparently was unstable, considering the patient could not maintain fusion through that amount of prism. However, either value can typically be used for a relieving prism prescription. Indeed, both of these values were less than the prism value (6^{Δ} BD

OS) that fully neutralized this patient's deviation on cover test. This is to be expected because fusion is allowed during both associated phoria testing and fusion prism testing.

One of the significant results of this case study is that the vertical associated phoria (and thus the need for prism) was eliminated after completion of the VT program. It has been suggested that VT can improve vergence adaptation or slow fusional vergence.[9,10] In contrast to the fast fusional vergence system, which responds quickly to disparity of the retinal images, the slow fusional vergence system allows stable binocular alignment over time.[9] Slow vergence develops as a response to stimulation of the fast vergence system[11] in order to relieve stress on the fast system. Slow vergence can last for up to eight hours during sleep, as an aftereffect of vergence stimulation that persists while no fusion is being maintained.[11] Cooper believes this long-lasting quality of the slow vergence system can account for the lasting effect of VT.[5] He suggests that the benefit of VT for a vertical deviation occurs by first eliminating diplopia with prism, then working with the fast horizontal vergence system, which subsequently causes change in the slow vergence system.[5] Improvement in slow vergence adaptation results in a smaller magnitude of fixation disparity and improved visual comfort.[9] Furthermore, it has been suggested that there is a feedback mechanism in which slow vergence adaptation causes muscle length adaptation.[12] Muscle lengths can change over time by the addition or removal of sarcomeres in response to the eye posture.[13] Thus, maintenance of fusion may lead to a smaller deviation and a reduced associated phoria, as in our patient.

By performing standard horizontal vergence VT to address the exo deviation through gradually decreasing spectacle prism (BD OS in this case) as well as through "stress" prism (BU OS in this case), vertical vergence adaptation increased.[1,5] Additionally, rapid changes in vertical vergence were practiced using jump vergence activities with loose prisms, an approach that is recommended over smooth vertical vergence therapy.[1] As might be expected, vertical vergence ranges in this case were not changed significantly,[5] whereas a more recent study of vertical vergence training found an average change in vertical vergence amplitude of approximately 2$^{\Delta}$, with a range of up to 6$^{\Delta}$.[14] However, because the patient developed better vergence adaptation, vertical fixation disparity and associated phoria eventually decreased to zero, indicating that prism was no longer needed.[9] Because our patient continues to maintain fusion and has pathologic diplopia awareness, the results of her VT should remain stable for the foreseeable future. Some patients treated with step-wise reduction in vertical spectacle prism within a VT program may reach a plateau where a minimal amount of maintenance prism may be needed long-term.[1,5] A smaller amount of vertical prism would reduce spectacle lens thickness and cost and might allow the option of using a contact lens prism.

Conclusion

Although VT for vertical deviations is not the primary treatment option due to the challenge it poses for many patients, those with high motivation may be able to develop better vertical vergence adaptation. These patients may achieve the goal of alleviating their symptoms without needing to wear prism long-term.

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[a] Bernell Corporation, Mishawaka, IN (http://www.bernell.com)

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