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A Deliberate Set of Examinations and the Application of Yoked Prisms in the Treatment of Visual Midline Shift Syndrome: A Case Report

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ABSTRACT

Background: Visual midline shift syndrome (VMSS) is an uncommon sequela of mild traumatic brain injury (mTBI). Untreated, VMSS may contribute to vague complaints of visual discomfort and balance or postural dysfunction. Identifying and treating this condition may improve visual outcomes and quality of life for an mTBI patient.

Case Report: A 24-year-old female Soldier with a history of at least one concussive event and complaints of drifting when walking, photophobia, asthenopia, and persistent visual blur presented to the optometry clinic via a referral from her nurse case manager. Her initial visit failed to yield any reliable information regarding her symptoms due to fatigue, over-medication, and distraction, so we delayed any treatment until she could return in a better state of mind. Over her next four visits, we conducted a full ocular health examination and an extensive neuro-optometric evaluation, and we diagnosed her with convergence insufficiency and VMSS. We then issued corrective lenses and yoked prism in a stepped fashion. She responded progressively better to each intervention, and one month after her final visit, she was largely visually asymptomatic.

Conclusions: A deliberate approach to care and a thorough neuro-optometric examination is indicated for any patient manifesting visual sequelae of mTBI during their initial comprehensive ophthalmic examination. Proper treatment of subtle dysfunctions evident only upon careful evaluation and consideration of all of a patient's concerns can have a positive impact on the patient's quality of life.

Keywords: convergence insufficiency, egocenter, mild traumatic brain injury, neuro-optometry, post traumatic vision syndrome, visual midline shift syndrome, visuo-spatial, yoked prism

Introduction

Mild to severe traumatic brain injuries are well known to have immediate and persistent effects on vision and the visual system.[1] These effects are highly variable and in some cases may be quite subtle to the observer. Post-injury vision may be correctable to 20/20, and no significant binocular vision problems may be evident, yet the patient may still complain of vague visual discomfort and difficulty reading or concentrating. An acute observer may diagnose patients with slight vergence, accommodative, or oculomotor dysfunctions that either did not exist prior to the trauma or were appropriately compensated and therefore were not evident in previous examinations. This constellation of symptoms and their respective characteristics is frequently referred to as post-traumatic vision syndrome (PTVS; Table 1). Patients may also have complaints of imbalance or reduced coordination. In severe cases, a patient may develop inefficient compensatory postural habits, leading to neck, back, or leg pain after a head injury. Advanced testing may reveal that their sense of visual straight-ahead has changed and no longer aligns with the environment, causing slight physical contortions in an effort to rectify the disparity. This condition, called visual midline shift syndrome (VMSS), is a less common but well-documented phenomenon that may occur in up to 50% of patients after certain types of neurological insults.[2] Dr. William V. Padula of Guilford, CT has described VMSS as a mismatch of visual and spatial information processed by the brain. Common symptoms of this syndrome are listed in Table 2.

Table 1: Characteristics and Symptoms of Post-Trauma Vision Syndrome[3]

Common Characteristics	Common Symptoms
Exotropia	Diplopia
Exophoria	Blurred near vision
Convergence Insufficiency	Perceived movement of print or stationary objects
Accommodative Insufficiency	Asthenopia
Oculomotor Dysfunction	Headaches
Increased Myopia	Photophobia

Padula has built greatly on the work of Trevarthen and Sperry to explain vision as a bimodal processing system composed of both focal and ambient vision.[2] He explains that the "focal" process is largely concerned with detail discrimination and is referenced primarily to function in the visual cortex. This focal visual system consists of around 80% of the visual fibers, either via the lateral geniculate body to the

Table 2: Common Symptoms of Visual Midline Shift Syndrome

Poor or altered posture
Poor or decreased balance
Altered gait or sense of drifting while walking; "tilted floor" phenomenon
Less commonly, vertigo
Less commonly, spatial disorientation in complex visual environments

visual cortex or through the pretectal nucleus in the pupillary constrictive system. At the same time, and more germane to our discussion, the "ambient" process matches visual information coming from the environment with kinesthetic, proprioceptive, and vestibular information generated by the body to build a visuo-spatial environment. This system gets its visual input from the 20% of the visual fibers that travel to the superior colliculus (SC). The SC serves to merge these information feeds and to start a feed-forward system wherein the midbrain communicates with the visual cortex and other areas of the brain to establish a spatial construct and to provide an organizational framework for other cognitive perceptual processes. Accurate saccadic movement is an example of a visual task enabled by this framework. Saccades require non-occipital cognitive effort to anticipate movement, to release attention from the former object of regard, to release the visual image, and to recognize the intended new point of regard. A compromise in this process is not likely completely to prevent fixation but will very likely cause delays or inaccuracies in fixation. Subtle saccadic dysfunction is a potential source of visual inefficiency and general discomfort for an mTBI patient and is, in fact, measurable by a keen observer. Similarly, appreciation of an accurate midline is visual task-dependent on the ambient system and its associated non-occipital functions; deficiencies in appreciation of the midline are in many cases measureable in systems disrupted by brain injury.

Padula defines the concept of visual midline organization as "the pre-conscious ambient visual concept of the lateral and anterior-posterior axes related to the perceived body center for sense of position." This organization arises during childhood development as an infant gains the ability to focus attention on an object, then develops the ability to turn and flex his head and neck to follow an object in space. The infant eventually sits, crawls, stands, and walks only when it directly interacts with the physical world, appreciates its own orientation against gravity, and allows the ambient system properly to merge its visual, proprioceptive, kinesthetic, and vestibular inputs. The child falls many times until these inputs align properly in a functional system; the result is appropriate posture and gait. A child with a successfully established ambient system tends to maintain an intact system (and therefore, proper posture and gait) throughout his life. Disruption or delay of visual or spatial signals into the system after an injury will force the system to adjust that midline organization, resulting in a compression or expansion of internal space to accommodate the new information.[3] This alteration in internal space is

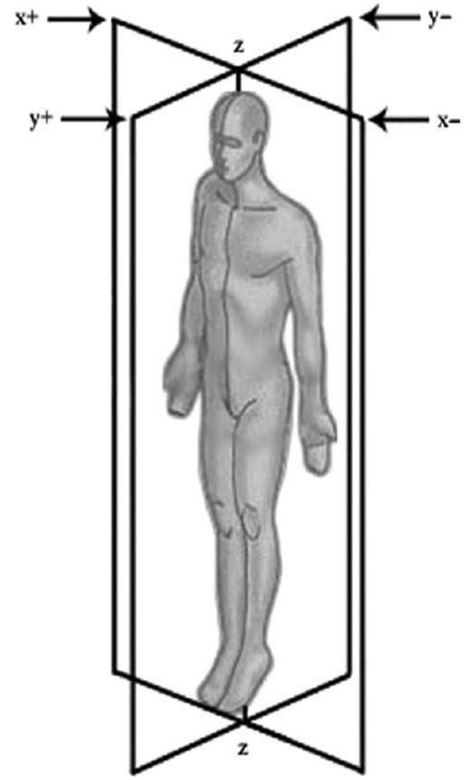

Figure 1. *A graphical representation of ambient visuo-spatial volume affecting egocenter*

then transmitted via the feed-forward mechanism previously described to the occipital cortex to be projected into the subject's external space.[4] The subject will no longer be able accurately to assess his midline given this faulty projection; the disparity between the subject's physical axes and his ambient sense of midline (the "midline shift") is frequently detectable by careful measurement.

Clinically, a subject's perceptions of midline on his x- and z-axes (Figure 1)[2] are evaluated during a comprehensive neuro-optometric exam, where the examiner simply moves a pen or fixation wand in front of the patient and requests him to respond when the object is centered on his midline.[5] Alternately, a patient can face a large blank wall or whiteboard, and the examiner can present a stimulus either by moving a small high-contrast target or by using a laser pointer. Houston proposes a more precise method, identifying deficiencies in the "Eye-Head" and "Hand-Head" egocentric midlines while minimizing potentially confounding visual or proprioceptive cues. Regardless of technique, the examiner should present the stimulus multiple times to the patient to gain reliable information on right, left, anterior, or posterior shifts in midline.

Once identified, a common therapy to address the shift is the application of yoked prism effectively to recalibrate the focal and ambient systems by leveraging the optical properties of prisms. The term "yoked" refers to the practice of placing the prisms with the bases in the same direction (base left or base right). To understand the benefits of this technique for VMSS, a review of the optical properties of prisms is appropriate. Every prism shifts light towards its base, but a prism does not bend all light uniformly across its surface.[6] Relative to each other, light rays at the base are bent slightly less, and rays at the apex are bent slightly more. There occurs an overall shift in the image towards the apex, but the resulting image is not a perfect copy of the original image. The visual field closest to the base has been effectively compressed, and the visual field closest to the apex has been effectively expanded.

The focal system does not appreciate the shift or the expansive/compressive effects; the prisms shift the image of the world in one direction but continue to provide unadulterated details for the focal visual process to continue to function. In fact, a patient can actually see a benefit from the lenses if the provider prescribes the appropriate ametropic correction. Concurrently, the slight alteration of space corrects the inappropriate expansion and compression occurring in the pre-conscious ambient system. The result is a newly restored visual processing system more closely aligned with the patient's proprioceptive, kinesthetic, and vestibular systems, thereby improving balance, gait, and, ultimately, posture.

In practice, the provider must not only carefully measure the patient's refractive error, but also properly address the direction and magnitude of the patient's midline shift. In cases of a lateral midline shift, the prism should be designed with the bases in the direction opposite to the patient's altered midline. For example, in a patient with a left midline shift, his ambient center is displaced to the left, and he will tend to stop the examiner's wand when it is to the left of his nose. Therefore, base right prisms will provide this patient the best benefit, thereby bringing the visual "center" into alignment with the patient's projected ambient "center." Determining the dioptric power of the prism required for a given patient is largely subjective; multiple combinations should be tried before settling on a final prescription. Generally, as the patient's midline shift is usually only a few degrees, the dioptric power will be relatively low.

A patient with an anterior shift presented with a vertically moving target will stop the examiner while the stimulus is still lower than eye level. This patient suffers from a compression of his ambient space at near and a corresponding expansion of ambient space in the distance. In a pre-conscious attempt to align the visual and proprioceptive systems, he may tend to employ flexion, or a constant bending forward. To compensate for this, a patient will commonly have "a tendency to extend [his] spine and thrust [his] weight backwards, leading to excessive lumbar lordosis, kyphosis of the thoracic spine, and hyperactivity of the lumbar paravertebrals."[7] This disparity is addressed with base down prisms. Base down prisms will optically expand the wearer's immediate visual space and compress the ambient space in the distance. Conversely, a posterior shift gives the patient inappropriate expansion of his immediate space and compression at distance, which causes a primary extension and a compensatory flexion. Constant flexion may "contribute to postural imbalances such as kyphosis, scoliosis, and sway back."[7] Base up prisms provide the appropriate counteraction to this deficiency in the ambient system. In both cases, the primary and compensatory spinal flexions and extensions are reduced, and the patient can ambulate through his environment more efficiently and, presumably, more comfortably. In at least one case study, an athlete with persistent sacroiliac dysfunction responded very well to this therapy even when traditional physical therapy methods failed.[8]

Case

A 24-year-old Hispanic female Soldier was referred by her nurse case manager to the optometry clinic at Fort Sam Houston, TX for a full optometric examination. At the time, the Soldier was undergoing a medical separation from the Army and was assigned to the Warrior Transition Battalion (WTB), a unit with the special mission to "provide competent and compassionate leadership through command and control, complex case management, comprehensive transition planning, and primary care in a safe environment that promotes the optimum healing for the wounded, ill, or injured Soldier that will return to the force or transition to civilian life as a productive Veteran."[9]

Medical History

In the summer of 2011, she was struck in the head by a vehicle turret during mobilization training for her military deployment. According to the patient and subsequent medical records, she lost consciousness for around 2 minutes and was treated that day by the unit medic but did not seek medical care at a hospital or by a primary care provider. Over the next two years, the Soldier was a victim of at least two physical assaults. The first event occurred while she was deployed and caused a great deal of distress and anxiety. She was diagnosed with post-traumatic stress disorder (PTSD), and her command transferred her from theater to the WTB at the San Antonio Medical Military Center (SAMMC) to be evaluated for continued military service. While her case was under review, her anxiety and headaches increased, and her physical condition deteriorated to the point where she required a cane to ambulate. During a counseling session at the WTB, she mentioned to her case manager a variety of visual symptoms, including persistent visual blur that started after the head injury in 2011. She also complained of current excessive light sensitivity and headaches when reading or using the computer. These visual problems were not corrected adequately with the last pair of spectacles provided to her at Fort Bliss, TX. By the time we saw the Soldier, she had been diagnosed with mild traumatic brain injury (mTBI), PTSD, major depression, dyssomnia, chronic back pain, and headache syndromes.

Besides the problems described, she had no other significant medical conditions. She was a light smoker and denied alcohol or illegal drug use. Her only allergy was to latex, and she was taking the following medications: (for anxiety) clonazepam 1mg tab tid, hydroxyzine pamoate 50mg cap tid, venlafaxine 150mg qd; (for sleep) trazodone 1.5x100mg tab qhs, ramelteon 8mg qhs; (for pain) tizanidine 4mg tab tid; (for headaches) propranalol 80mg cap qd, rizatriptan 10mg tab at onset of migraine; (for birth control) drospirenone/ethinyl estradiol 20mcg/3mg qd; (for constipation) sennosides/docusate 50mg bid; (for allergies) loratadine 10mg tab qd; (for asthma) levalbuterol 45mcg as needed. Her last eye exam was 17 months prior (May 2012), and she noted headaches and progressively blurry vision since the concussive incident in 2011. The exam revealed a slightly myopic refractive error, for which she was issued full-time spectacles.

Vision Assessment

Our Soldier suffered her most recent assault about three weeks before we performed the first vision examination in our clinic. The incident exacerbated her existing back pain and, naturally, her general level of anxiety and emotional distress. This led to several medication adjustments; she was still being assessed for their effects on the day she presented to us. At her initial appointment with us in October 2013, she was late, mildly disheveled, and dysthymic. She did not bring her old glasses but reported that she rarely used them because they "no longer work[ed] for her." She reported that the visual blur and photophobia that started after the concussion in 2011 had persisted but were stable. When questioned more closely, she also reported several other visual changes since the injury: inability to read comfortably for more than 30 minutes, words blurring in and out of focus when reading, difficulty keeping place when reading, occasional closing or covering of one eye to see more comfortably, and a history of "drifting" or bumping into walls when walking. She also noted that the drifting feeling was worse while driving; she had recently been in several small automobile accidents when she inadvertently "side-swiped" other cars or structures. She was currently using a cane for chronic back pain; important to our case is the observation that her complaint of drifting while walking predated the back pain but did not exist before the head injury. She reported no ocular discomfort but suffered from chronic headaches.

Pupils were round, and we noted them to be excessively reactive during the swinging flashlight test. We noted that her extraocular movements were jerky in all directions with continuous, irregular, rapid fixation corrections, especially while in upgaze. Her confrontations were full to finger count, and the distance cover test revealed unsteady fixation with frequent, irregular, vertical corrections in gaze, equal between the eyes. At distance, the cover test revealed a highly variable exophoria that we estimated averaged around 10 prism diopters. Non-contact tonometry (NCT) was 13mmHg and 12mmHg. Her anterior segment findings were unremarkable, and an undilated posterior segment examination by 90D lens revealed fleeting views of a healthy fundus with a round healthy disc and a cup-to-disc ratio of approximately 0.25 OU.

That day's autorefraction (AR) revealed less myopia and more astigmatism than we expected from her previous manifest refraction (MR). Conversely, that day's MR revealed more myopia and astigmatism than her previous exam. Her responses during refraction by phoropter were very slow, incomplete, and variable. We halted her MR at OD: -1.25 -0.50x160 (20/20^{-1}) and OS: -1.00-0.25x020 (20/25) when it became clear that the patient could not concentrate on the task. At near, she subjectively benefitted from a +1.00 ADD to bring her to 20/20 OU. NRA/PRA through this ADD was +1.00/-0.75. Again, her responses were variable. During the refraction, the Soldier reported that she couldn't concentrate on the letters partly because they were "moving and shaking" left and right when her fellow eye was occluded. Examination of eye movements outside the phoropter did not reveal any monocular or binocular nystagmus.

At this point, we decided to halt the exam and bring the patient back at the next available opportunity, as it was clear that the patient would be unable to provide enough information to determine an accurate prescription or to identify any subtle binocular vision problems. We also wanted to provide the patient with a full dilated fundus exam (DFE) to rule out any organic etiologies for her visual complaints. The Soldier agreed, and we released her for the day. We contacted her case manager with our concerns and coordinated a date for her return. We strongly suggested that the Soldier return to our clinic early in the morning to mitigate the effects of fatigue, and we requested that she not have any other medical appointments set for that morning so that she wouldn't feel rushed or anxious during our exam. We evaluated her current medications for adverse effects on the visual system, especially accommodation; we found that eight of the Soldier's twelve medications have a known side effect of "visual changes" or "blurred vision" (Table 3).[10]

At the next exam (November 2013), the Soldier presented much more alert and responsive. Entering acuities were OD 20/20^{-1} and OS 20/20 without correction; NCT was 9mmHg OD and OS. We found her manifest refraction to be OD: -0.25-0.25x165 (20/20) and OS: -0.50 sph (20/20) with no ADD needed for 20/20 OU near vision. Her NRA/PRA improved to +1.25/-1.00, which is balanced but still slightly lower than we expected for her age. Pupils, extraocular movements (EOMs), cover testing, confrontation fields, and anterior segment findings were all normal; she displayed no irregular eye movements at all. We trial framed the full MR, and the Soldier noted good subjective comfort in the chair and while walking around our hallway. We dilated her with 1 gtt cyclopentolate 1% and 1 gtt tropicamide 1% and waited 45 minutes for the full cycloplegic effect to occur. Her CRx was OD: plano-0.25x165 (20/20) and OS: -0.25 sph

Table 3: Medications and Known Side Effects

Medication	Known visual side effects (incidence)
Clonazepam	Vision changes (rare)
Hydroxyzine pamoate	Blurred vision
Venlafaxine	Changes in vision, such as blurred vision (more common)
Trazodone	Blurred vision (more common)
Ramelteon	None
Tizanidine	Blurred vision (less common)
Propranolol	Blurred or loss of vision, double vision, disturbed color perception, halos around lights, night blindness, overbright appearance of lights, red irritated eyes, tunnel vision, dry eyes (incidence not known)
Rizatriptan	Blurred vision, dry eyes, eye irritation (less common)
Drospirenone/ethinyl estradiol	Vision changes, yellow eyes (incidence not known)
Sennosides/docusate	None
Loratadine	None
Levalbuterol	Discharge from the eye, eye itch (less common or rare)

(20/20), which are normal values that reflect an appropriate release of tonic accommodation from an accurate dry MR. This "wet" refraction ruled out latent hyperopia, and given her myopic MR at the previous exam, provided an insight into the Soldier's original complaints of blurry vision. Her DFE was unremarkable. We ordered a two pairs of full-time distance vision (DV) spectacles for her (one with 15% grey tint and one clear) and instructed the patient to pick up the glasses from us in two weeks. At four weeks, our intent was to assess her comfort with the new spectacles and conduct an extended binocular vision assessment. Important for her ongoing medical fitness review, we determined that she met all requirements for ocular health and visual function per Army Regulation (AR) 40-501, Chapter 2-12 (Eyes) and Chapter 3-16 (Vision).

At one month, the Soldier reported to the clinic for her neuro-optometric exam but had not yet picked up her spectacles. When presented with the new DV spectacles, she reported good subjective comfort with both sets of lenses. All entrance and anterior segment findings were normal. We have summarized her findings from the examination in Table 4.

We performed the midline shift test in the following manner: The patient was comfortably seated in the exam chair in full illumination. We provided the patient with the following instructions: "I am going to move this pen slowly across your field of view. I would like you to tell

Table 4: Examination Information (all BV findings through manifest refraction)

Procedure	Findings	Normal Values	Interpretation
Manifest Refraction	OD: -0.25-0.25x165 20/20 OS: -0.50 sph 20/20	n/a	n/a
Cycloplegic Refraction	OD: pl-0.25x165 20/20 OS: -0.25 sph 20/20		
Stereoacuity	140" circles, 100" animals	20"	Low
Worth 4-Dot	Suppression OS at D; Fusion at I, N	Fusion at 6m, 1m, 40cm	Focal suppression OS
NPC (accommodative target)	14 cm/17 cm	Break 5 cm, recovery 7 cm	Low
NPC (non-accommodative target)	20 cm/24 cm	Break 7 cm, recovery 10 cm	Low
Distance Cover Test	1 XP	Ortho	Ok
Near Cover Test	4 XP'	4-6 XP'	Ok
Distance VG	Horiz: Ortho Vert: Ortho	Ortho H/V	Ok
Distance BI (step)	x/8/5	x/7/4	Ok
Distance BO (step)	x/12/6	x/11/7	Ok
Near VG	Horiz: 4 exo Vert: Ortho	4-6 exo	Ok
Near BI (step)	11/18/14	x/13/10	Ok
Near BO (step)	22/24/8	x/19/14	Ok
NRA/PRA	+1.25/-1.00	+2.00/-2.50	Both low, worse PRA
Accommodative Amps (ML)	6.5D OD/OS	18-(age/3)=10	Low
AC/A (+2.00 method)	9 exo VG => (9-4)/2 = 2.5:1	4:1	Low
Vergence Facility (12BO/3BI)	9 cpm, trouble with BO	15 cpm	Low
MAF (+2/-2)	OD 12 cpm, OS 13 cpm	11 cpm	Ok
BAF (+2/-2)	9 cpm, trouble with plus	8 cpm	Ok
Double Maddox Rod Test	No cyclotorsion	No torsion	Ok
Saccades	2 small under-shoot corrections in all gazes	Accurate in all gazes	Low accuracy
Pursuits	Smooth, full range of motion	Smooth, full	Ok
Midline Shift Test	2"-3" consistent left shift	No shift	Shift left

me to stop when the pen is directly in front of your nose. Please don't look at the pen though, and don't look at me, just relax your eyes and try to focus on an imaginary point in the distance. You may use the chart on the wall if you'd prefer. Do you understand?" Once the Soldier acknowledged understanding, the examiner positioned himself directly in front of the patient at approximately 75 cm and started moving the pen inwards at about 4 inches per second from the patient's far left periphery. When the patient said "stop," the examiner assessed the location of the pen in relation to the patient's nose by quickly alternating between his eyes to reduce parallax. He repeated this patient-left to patient-center movement three times and estimated an average value based on patient response. He then conducted the same movement and analysis three times from the patient's far right. The examiner then averaged the results from the trials in each direction to determine the direction and magnitude of shift from the patient's center line, defined by the location of her nose. Important in these multiple measurements is the assessment of consistency in patient response. A consistent localization to the left or right is more diagnostically reliable. Equal lead or lag from each side may not reflect a true midline shift but may represent a cognitive or perceptual dysfunction outside the scope of this particular test. Our Soldier demonstrated a consistent shift of about 2" to 3" to the left of true midline on every trial.

Impression

The diagnoses were: history of concussion (V15.52.0), refractive error–myopia (367.1), astigmatism (367.20), gaze convergence palsy (378.83), visuospatial defect (799.53).

Treatment

Our initial strategy was to address the existing refractive error by prescribing her MR in FT DV spectacles in standard military issue frames, which the patient found adequately decreased her DV blur when trial framed. We also ordered pair of 15% tint spectacles with her MR to address the photophobia. At one of her follow-ups, she reported that she wore the DV spectacles most, but not all, of the time. She reported that wearing the tinted lenses was helpful, but she usually just wore civilian non-prescription sunglasses because they were darker and looked better. She elected not to order darker lenses in the standard fames at that time. Department of Defense policy authorizes us to provide photochromatic lenses to Soldiers diagnosed with mTBI, but this Soldier did not express a desire for that type of lens. Regarding her convergence insufficiency, our primary strategy was to provide a slight ADD (+1.00 sph OU) with a small amount of base in (BI) prism (3^BI OU). We trial framed the proposed NVO prescription in-office, and the Soldier reported good subjective comfort and vision. We also discussed a few of the more common home vision therapies, including Brock string and "pencil pushups," but the Soldier elected to wait for the NVO spectacles. When the spectacles arrived a few weeks later and the Soldier tried them on, she again reported good subjective comfort and vision, and we dispensed them to her, with the instructions to use them as much as possible when reading or using the computer for the next few weeks and return in six weeks for a follow-up.

The use of BI prism for CI is not an optimal solution; full correction of ametropia and vision therapy (VT) for sensory fusion are generally preferred as first options. If VT is unavailable or unsuccessful, small amounts of BI prism can be used in cases of CI. A good fixation disparity analysis should be used to prescribe the appropriate BI prism.[11] Our facility is not equipped to measure fixation disparity accurately or to provide vision therapy services. Given these restrictions and the lack of patient motivation to start therapy, considering that the Soldier would very soon separate from the Army and keeping in mind the reduced accommodation identified during testing, we elected not to pursue VT but to provide near NV spectacles with a small ADD and low BI prism as a trial. We believed that this choice would likely provide the best benefit in the shortest amount of time in this particular case.

Regarding the midline shift, we trial framed the MR with a few combinations of base right prism, and the patient responded favorably to 3^ base right OU. We prescribed the right-yoked prisms with her MR, and the Soldier elected to get these spectacles with photochromatic lenses. At her dispensing visit a few weeks later, the Soldier remarked immediately that the vision and comfort of these yoked prism spectacles were superior to her current lenses and that she felt like "the world seemed straighter" to her right away. We walked the Soldier down the hallway and around the clinic with ease, and the Soldier reported no dizziness or distortion with the new lenses. Before completing the lap around the clinic, she requested permission to wear these new glasses "all the time" instead of her older ones. We encouraged her to allow for an adaptation period of a few days before she tried to drive with them, but full time wear was approved. The Soldier was very thankful and encouraged that her overall comfort would improve.

Outcome

Ten days later, after we dispensed the yoked prism spectacles, the Soldier medically retired from the Army; she let us know by a recent phone call that she still has all the glasses and always uses the yoked prisms to drive. She feels much more confident driving and has had no "side-swipes" or close calls while wearing these lenses. She uses the DV specs most of the day unless she is reading for more than a few minutes; in that case, she switches to her BI NVO spectacles. She is working full time and is very happy with the results of our therapy, especially her increased confidence in driving. As she is no longer eligible to be seen in our clinic, we are unable to follow her and measure quantitatively any changes in her visual comfort since our intervention. Given the opportunity, we would be very interested in objectively assessing any such changes. We are also curious to assess any changes in her back pain, as there is a remote possibility that at least some of her sacroiliac pain may have developed from poor posturing due to her visuo-spatial imbalance. We must note that while we are happy with the Soldier's response to our correction of her lateral shift, we failed to conduct testing for anterior or posterior shift, for which proper correction could potentially have an even greater effect on overall comfort.

Conclusion

Every effort must be taken to identify uncommon problems properly (in this case, VMSS) and to apply uncommon solutions (in this case, yoked prism spectacles) to special needs patients. A properly engaged, educated, and equipped optometrist will provide the best possible chance for positive outcome. Our second point is that the importance of a deliberate approach to optometric care when working with a special needs population cannot be overstated. Our mTBI patients frequently present with visual sequelae that are sometimes confounded by the effects of multiple medications, by physical restrictions that may prevent proper evaluation, and by emotional or cognitive challenges that may not be evident upon initial examination. For example, mTBI patients frequently experience anxiety or fatigue during extended oculomotor testing and need more breaks than typical patients. In our case, the findings from our initial encounter with our Soldier were inaccurate and unreliable given her emotional and medical condition; subsequent examinations were much more productive. Work-ups like these may need to take place over several visits, and longer cycloplegic exams may require coordination with the patient's care manager to ensure that adequate time and attention are available for proper evaluation. With respect to treatment, we have also found that this population may benefit from frequent follow-ups, even for routine spectacle prescriptions. Very small adjustments that may seem negligible in the "normal" population provide outsized improvements in comfort in mTBI patients. Her small refractive error and slight convergence insufficiency may have been easily compensable by a patient without her medical history, but to her our intervention made a big difference.

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