Neuro-Optometric Rehabilitation For Persons with a TBI or CVA

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INTRODUCTION

A traumatic brain injury (TBI) or cerebrovascular accident (CVA) often leaves the person with multiple disabilities including impairment to cognitive function, speech, balance, spatial orientation and coordination. In most cases, referral for visual consultation occurs only if there is injury to an eye or if ocular pathology is suspected. However, it has been the author's experience that throughout the medical and rehabilitative treatment program, little regard has been given to the individual's level of visual function. Specifically, how the state of visual function affects posture, balance and coordination.

Posture while seated, standing or walking for many individuals is affected by neurological problems often causing hemiparesis or hemiplegia. The person often will have difficulty maintaining an upright position. They may maintain extension or flexion posture or lean to their left or right due to a paretic side. While the abnormal posture is initially due to neurological problems, the role of vision to provide spatial orientation has been overlooked.

The majority of individuals that recover from a traumatic brain injury or cerebrovascular accident will often have binocular function difficulties in the form of strabismus, phoria, oculomotor dysfunction, convergence and accommodative abnormalities. The abruptness of the binocular function problem makes compensation difficult, leading in many cases to horror fusionalis. This condition of diplopia can severely affect recovery from depth judgement, object localization, ability to match visual information with kinesthetic, proprioceptive, and vestibular experience, thereby affecting balance, coordination and movements. Movements may appear to be quite varied. It will be observed that the person experiencing this condition will demonstrate limitation to ocular movements as well as high muscle tone, particularly about the head, neck and shoulder area. Extension of the head and neck is often observed. The severe spatial disorientation that occurs with horror fusionalis may be a factor in the varying state of high muscle tone and extension posture in the seated position.

Due to the major impact of the visual system of cognitive function and motor development, the visual rehabilitative needs of the TBI or CVA patient must be addressed early and be integrated into all aspects of the rehabilitation program. The insult to the cortex produced from a TBI or CVA causes stress affecting the central and autonomic nervous systems. The effect on vision seems to be an interference with the ambient process that primarily appears to occur at the level of mid-brain where vision is matched with kinesthetic, tactual, proprioceptive and vestibular processes.

The visual condition that results from a head injury has been called by the author the Post Trauma Vision Journal of Optometric Vision Vision Development.
Syndrome (see Figure 1). It has been named this to emphasize that the condition is caused by a disruption to the ambient process of vision and the exotropia that often occurs is a result of the greater visual problem.

There may be compensations to attempt to deal with the disruption of the ambient process and malalignment of the eyes. Suppression in most cases has not developed since the brain has not adapted to the strabismus. Therefore, individuals will developed abnormalities in head posture and/or motoric function in an attempt to cover or block vision from one eye. The variations in posture will affect midline concepts thus interfering with the seated posture.

When there is an interruption to binocularity causing stabismus following a head injury, it is the author's clinical experience that the person's concept of their own visual midline shifts usually toward the sighting eye. However, it has been found that the midline may be variable or there may a paradoxical shift toward the deviating eye. The binocularity that was present for most persons prior to the injury provided the person with matching experiences between the ambient visual process, kinesthetic, proprioceptive, tactual and vestibular systems to establish a concept of midline and position space. The effect of the strabismus following head injury interferes with this matching process which in turn will affect position sense and midline concept. In the situation when diplopia occurs, by patching one eye the diplopia may be eliminated but often it will negatively affect posture and midline concepts.

POST TRAUMA VISION SYNDROME

Considering that the visual process plays a primary role for motor organization and cognitive development, the visual process should be examined during an early state in the rehabilitation of person with traumatic brain injury. The visual system will demonstrate changes that are a direct result of the insult to the cortex. These changes will be in both refractive imbalances, fixations, saccades and other sensory-motor relationships. The sooner visual intervention can be established for the person with a TBI or CVA, the faster and more complete the recovery.

When developing a rehabilitation program for vision, the examiner must keep in mind several factors that seem to typify those patients who have had a traumatic brain injury. In normally sighted patients that have not had traumatic brain injury but have exophoria and exotropia, behavioral observations reveal symptoms of staring, frequent day-dreaming, loss of comprehension when reading, the need to re-read to understand context, and a lack of attention and concentration abilities. It is interesting to observe that many of these symptoms also occur for the TBI patient that also has a high amount of exophoria or an exotropia. Exophoria is not just a muscle imbalance. It is a barometer of motor and sensory organizational status for the individual.

Individuals with the condition of exophoria that has resulted from a brain injury will show a highly disorganized ambient function causing a very unstable visual state. One patient explained that persons would appear distorted. Faces would stretch in different directions, and when he moved his head, the walls moved and the floor appeared to bend and bow before him. Obviously, for this individual, mobility was very difficult for him to accomplish. He also had a high muscle tone in the head, neck and shoulder areas which restricted upper body movements.

Low amounts of base-in prism can be very effective in reducing some of these visual stress patterns. The base-in prism counters the spatial suppression affect that occurs in post trauma vision syndrome. As the visual stress is relieved primarily in the ambient function of vision, the focal processes involving higher perceptual processes, attention, and concentration is improved in function. Individuals respond quickly to the base-in prescription, reporting that they feel more comfortable or that their vision seems more stable.

In some cases, nasal patches (patches placed in the nasal portion of eye glass lenses) will be effective in providing structure to the visual field. The nasal patch also reduces demand on peripheral fusion. If base-in prism is not enough to help an individual reorganize the ambient process, nasal patching may assist further in this process.

Often persons with a hemiplegia or paresis will also have a homonymous hemianopsia (visual field loss on the affected side). It has been found that due to the field loss, the person loses awareness of visual space on the affected side. This in turn reinforces the neglect of the arm and leg on the affected side. The midline will eventually be shifted so that weight transfer to the affected side is affected. The seating posture or posture while walking will not be maintained in the erect position because of the shift of the visual-motor concept of the midline. This condition may also occur with inferior or superior field losses thus causing an extension or flexion posture. While a visual field loss is a primary contributor to abnormal midline concepts, it has been my experience that these conditions can be present without visual field losses particularly when a strabismus occurs as previously discussed. The author has termed this condition the Visual Midline Shift Syndrome.

The long term adaptive result of the visual/neuro-motor system to the midline shift seems to be to distort space in order to enable the person to develop some warped state of balance between vision, kinesthetic, proprioceptive, tactual and vestibular systems. The results will be to tilt the horizontal plane of space in one direction or the other. In turn, leaning to the left, right, forward, or backward will actually align the person to the distorted portion of the horizontal plane (ie. the floor). It is the author's experience that some persons may actually perceive this distortion and verbally report it while the majority do not because of the gradual adaptation of the visual process.

The author has found that prism therapy regimens can be very effective in attempting to re-establish balances in the visual-motor relationships. Yoked prisms, meaning that the base end of the prism should be placed in the same
orientation of both eyes, can be very effective in making changes in the oculomotor state which thereby affects sensory function. Each time a prism is introduced before the eyes of an individual in a tandem or yoked fashion as described, the eyes will reorient to look at the image of the object in a new position. The muscles of the eyes will turn the eyes to look at the object at this position in space. The important factor is that when the motor system re-adjusts, it sends information to the cortex that states that the sensory component must re-adapt itself to this new position in space. This effect causes a re-orientation of motor and sensory organization in the cortex.

The prism has the effect of expanding and contracting space and it is this effect that counters the visual distortion experienced by the person. This effect is also responsible for shifting the concept of the visual midline. For example, if an individual were to have base-up prism placed before his eyes, the sensory component of his visual system would see the world much lower than what he had previously. The oculomotor system related to the cortex that since the eyes are being turned downward, the environment must be in lower position. The general orientation to the environment established to alter balance. More importantly, the base up yoked prism has the effect of expanding and contracting near space and expanding far space causing the experience of tilting the floor downward.

The opposite effect occurs when base-down is introduced before both eyes. The environment being shifted upwards causes the eye muscles to shift upward. Information received by the cortex re-orient the sensory component of vision and position sense. Posture is re-aligned so that the person will experience an effect of walking up a hill, thereby increasing extension. The effect of base down yoked prisms is to expand near space and contract far space. The visual component is so strong that it will cause the individual's relationship to the environment to actually change and there will be a shift in weight backward as if re-orienting to a shift in gravity. This shift in orientation to space may at first seem quite simplistic. One might believe that if the person shifts his weight in one direction or the other as an adaptation to the prism, once the shift is made then everything will appear the same. In reality, the effect of making a postural change to space creates a problem-solving attempt through the ambient visual process to deal with the spatial environment through a vision-neuro-motor relationship. If the person is successful in making this shift in motor orientation, it occurs not simply because of the eye muscles changing in position, but because of information matched and re-established between the sensory component of vision, the motor component of vision, the vestibular process, the kinesthetic and the proprioceptive inputs to the brain. The visual system acts to re-establish the balances between these systems when yoked prisms are utilized. Yoked prisms, therefore, can be an important approach to dealing with the rehabilitation of the person.

Base-left or base-right prisms can similarly be effective. With a lateral yoked prism, there is a spatial change to the left or to the right depending upon the type or prisms used. Wearing yoked base-left or right prism while attempting to walk, will produce some interesting motor changes. Very often posture will change due to the fact that the person will visually experience the environment as being slanted to the left or right, depending upon the type of prism. This orientation to space will cause the person to experience a weight shift to the left or the right because the midline is shifted. Therefore, utilizing a base-left or a base-right prism can be very effective in attempting to reorient the person to the left or right side of his body, particularly in cases involving a hemiplegia. This same affect is observed with persons who have abnormal postures while seated in a wheel chair.

CASE REPORT

For example, one patient had a right side weakness and placed most of his weight on his left side when seated; often falling over to the left. A test was developed to determine where the individual perceived his own midline. The examiner stood before the person and asked him to turn his head so that the patient thought that it was straight. The examiner then asked the patient to look at a small object and tell the examiner when the object was in front of between his eyes. The examiner proceeded to laterally move the object across the field from left to right. The patient said "stop" when he thought the objects was directly in front of his nose or between the two eyes. The patient was allowed to move his eyes in a pursuit fashion laterally across the field. The patient repeatedly told the examiner that the object was directly in front of his nose when in fact it was directly in front of his left eye.

By leaning to the left it may be understood that the person was experiencing a distortion of space causing the floor to be tilted up and to the right. Placing base right yoked prism before the person's eyes caused a perceived lowering of the floor on the right side and a re-establishment of midline concept that permitted the person to accept weight to be transferred to the right side. In turn, posture became more erect.

CLINICAL GUIDELINES

If the clinician is considering the prescription of yoked prisms for the TBI or CVA, an extensive Neuro-Optometric evaluation with lenses and prisms should be developed. There are several guidelines that the author can suggest in the prescription of these lenses. For the higher functioning TBI patients, evaluate the patient's posture in the seated position. Observe for head turns to the left or right and for extension and flexion patterns of the head or neck. Also examine motor function while walking if possible. Observe for head positional changes that will occur when walking. In addition, observe general alignment of the neck and shoulder in relation to movement of the pelvis when extending the left and right foot forward.

For individuals that are showing a left to right side weakness, observations should be developed concerning posture in a seated position, reaching and/or walking. Base-left or right yoked prisms should be used in an attempt to re-establish midline concepts. When prescribing yoked prisms, the examiner may want to recommend...
that the prism be used during the day. This doesn't allow total adaptation to the prism and will cause the individual to have to reorganize sensory and motor functions when the prism is not in place. A lens or prism is an extremely potent means of re-establishing the motor relationships to sensory processes as well as matching information between vestibular, proprioceptive and kinesthetic stimuli. If the prisms are utilized for several hours at a time, then taken away, very often carry over will be observed and experienced by the individual after the prisms are removed.

Yoked base-up or base down prisms can be used similarly to shift the person's extension or flexion patterns; base-up or base down prisms can be used similarly to shift the person's orientation to space. For individuals that have demonstrated extension or flexion patterns, base-up or base-down prism may be effective for changing some of these motor postures. If a TBI or CVA patient shows extension and motor spasticity when attempting to walk, very often he will also demonstrate a wide stance and rigid posture. Base-up prisms can sometimes be effective in enabling the person to experience weight shifts forward. Base-up prism has the experience of walking down a hill. Sometimes the use of this prism can be effective in causing the person to shift weight more forward opposed to backward. If the clinician can utilize prism to enable the person to problem-solve by shifting weight, a major step has been established more control over the environment, posture, movement and orientation to space. With base-up prism, if the person experiences a weight shift forward, then it is an experiences that will be utilized for future balance relationships.

Base-down yoked prism can be utilized at times for individuals that are showing extreme flexion. For one individual who was non-ambulatory and wheelchair bound, flexion of the head and neck were observed and the person only lifted his head for very short periods of time. The prescription of base-down prism demonstrated an immediate affect causing the person to lift the head and re-orient in line with the torso. Capital flexion was increased (capital flexion is the extension of the back of the neck and the decrease in the angle between the chin and the sternum). This can only be accomplished when the person lifts his head and orients it in an erect fashion over the spinal column.

In working with many low functioning TBI and CVA patients, it has been noted that the introduction of base-in, base-up, base-down or base-left type of prisms may induce a number of visual changes such as increased pursuit activity, increased saccades, changes in blink, relationships, and release of motor spasticity. A number of low functioning TBI patients have demonstrated extension of the head, neck and also the jaw. After several weeks of use with base-in prism, there has been observed a release in the extension and spasticity of the temporal-mandibular joint in some patients. When this occurred, patients frequently began to close their mouths and also masticate, demonstrating increased tongue activity spontaneously. Speech pathologists and other therapists found these changes in the temporal-mandibular joint to be quite significant. In the case of several individuals, this release of extension was found each time the base-in prism was introduced. Those individuals demonstrating extreme extension of the temporal-mandibular joint and in the neck area showed spasticity of the arms, in addition to a high amount of exotropia.

It is unnecessary to prescribe high amounts of base-in prism to correct for the exotropia and exophoria. Many traumatic brain injury patients will actually show avoidance of high amounts of base-in prism. The examiner should approach the prescription of prism in a conservative manner, starting with low amounts of prism and increasing prism and increasing the prism to the point where positive changes begin to result.

The Neuro-Optometric rehabilitation examination of the TBI or CVA patient, particularly the low functioning patient, may have to be averaged over a series of examinations. This means that if at all possible the examiner should see the patient over several days. When therapists are available, the examiner may suggest the use of special types of prisms to be used over the course of the examination period. Detailed notes should be made with regard to motor capabilities and other functions so that the therapists can report back to the clinician. The end result will be a more detailed understanding of the effects of lenses and prism and how behaviors may be changed.

CONCLUSION

The Post Trauma Vision Syndrome (PTVS) and Visual Midline Shift Syndrome (VMSS) have been found to be prevalent among those persons who have suffered a TBI or CVA. Many persons who have the PTVS or VMSS are severely affected by their inability to accurately match information between vision and the motor centers for balance and posture. In turn, the PTVS and VMSS can severely affect posture and balance. The visual relationship through the ambient process must be recognized as contributing to these postural imbalances and that the syndrome is treated through Neuro Optometric rehabilitation approaches. It is important to emphasize that the PTVS and VMSS can be a significant obstacle affecting the total rehabilitation of the traumatic brain injured person.

(PADULA) POST TRAUMA VISION SYNDROME

Characteristics
- Exotropia
- Exophoria
- Accommodative Dysfunction
- Convergence Insufficiency
- Low Blink Rate
- Spatial Disorientation
- Balance and Posture Difficulties

Symptoms
- Diplopia
- Objects Appear To Move
- Visual Memory Problems
- Staring Behavior
- Poor Tracking Ability
- Asthenopic Symptoms

Figure 1: Common characteristics and symptoms associated with the (Padula) Post Trauma Vision Syndrome.
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GRAPHIC EYE
"I was an illustrator," remembers Nicole, "and after a long day of drawing I was not surprised when my sight was a little blurry. One day, however, I had been at my board for barely twenty minutes when I had double vision. I rubbed my eyes, but it didn't go away. I figured maybe I had too much coffee or perhaps I was getting a cold. I lay down for an hour, but couldn't stop opening my eyes to check my vision. It was still double.
"I called my boyfriend and he came over. By the time he arrived I had a headache, maybe as a result of my anxiety about my sight. Anyway, we figured my eye problems were probably a result of the headache and they disappeared after three or four hours.
"I thought nothing more of the incident until a month later when the double vision occurred again," Nicole goes on. "This time, however, it didn't go away the whole day, and since I couldn't work I went to an eye doctor. He couldn't find anything wrong with my vision beside my symptom, but he was concerned and alert enough to refer me to a neurologist. That started me down the road that eventually led to my multiple sclerosis diagnosis. The double vision improved, but other symptoms appeared that have left me unable to continue as a pen-and-ink illustrator. Fortunately I'm still able to use my graphic "eye" and I now create computer-generated designs."

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