USING THE VEP FOR BETTER PATIENT OUTCOMES IN MILD TRAUMATIC BRAIN INJURY

An optimal VEP test protocol can differentiate objectively between visually normal patients and those with mild traumatic brain injury.

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The area of traumatic brain injury (TBI), in particular mild TBI (mTBI), has come to the forefront of the clinical vision world due to the constellation of visual problems/visual dysfunctions secondary to the recent war efforts and also a focus on sports-related concussions/head injuries. These visual problems are present in thousands of our servicemen and women, and likely in a similarly large but unfortunately unknown number in the sports world, especially in the areas of football, boxing, and soccer.

Individuals with mTBI present with an array of general problems/deficits of a sensory, motor, perceptual, cognitive, linguistic, psychological, and behavioral nature. For example, an individual with mTBI might manifest gait, memory, and impulse control problems. In addition, and more specifically to the topic, they frequently exhibit a wide range of vision-related problems, including (1) basic refraction/ocular disease-based (eg, retinal tear), (2) binocular/oculomotor-based (eg, convergence insufficiency), and (3) nonoculomotor-based (eg, visual field loss) visual deficits, along with correlated symptoms, such as blur, diplopia, impaired reading, poorly sustained visual attention, visual motion hypersensitivity, and visual fatigue. Fortunately, there is a range of visual interventions that provide considerable relief.[1]

OBJECTIVE DIAGNOSIS

An area that is receiving ever more attention in mTBI is the use of objective documentation in the diagnosis, as well as the related therapeutic efficacy, of a visual intervention

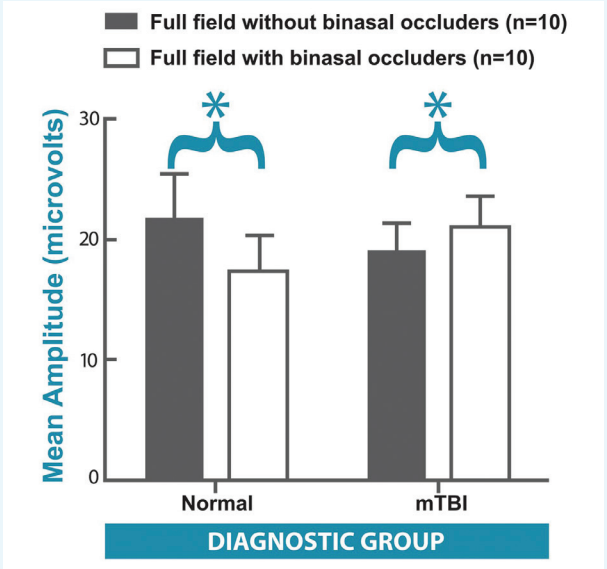

Figure 1. All control subjects exhibited significantly reduced amplitude with addition of the BNO as compared with their baseline. All 10 with mTBI and VMS exhibited significantly increased VEP amplitude with the BNO as compared with their baseline.

such as lenses, prisms, occluders, tints, and/or VT/VR. We have been studying these areas in our brain injury laboratory for the past 2 decades, especially regarding the oculomotor, accommodative, and pupillary systems. More recently, we have also been using the technique of the visual-evoked response (VEP) in our mTBI-related investigations with great success and resultant clinical insights. Herein are some of our ideas and results in terms of the

effects of binasal occlusion (BNO) and base-in (BI) prisms in those with visual motion sensitivity (VMS), the effects of oculomotor-based VT/VR, and lastly the development of a targeted, simple, rapid, and well-tested clinical VEP protocol to assist in the visual diagnosis, prognosis, and therapeutic effectiveness in these individuals.

MTBI WITH VSM

In our first study,[2] we tested 10 visually normal (VN) control subjects without VMS and compared them to 10 individuals with both mTBI and VMS to determine the effect of BNO on the VEP amplitude. Clinical prescription of BNO appears to help by reducing motion-related symptoms in many cases of mTBI.[2,3] Patients were assessed with their full refractive correction in place, as well as with the addition of the BNO. All 10 VN control subjects exhibited significantly reduced amplitude with addition of the BNO as compared with their baseline; in contrast, all 10 with mTBI and VMS exhibited significantly increased VEP amplitude with the BNO as compared with their baseline (Figure 1). In a subsequent and related study,[3] we tested both VN individuals and mTBI subjects with the symptom of VMS, but added BI prisms to the mix. Some believe that BI prisms are also helpful in these individuals in conjunction with the BNO.

Now, there were four test conditions: baseline with refractive correction only, with BNO added, with BI prisms added, and with both BNO and BI prisms added. The results were similar to our first study.[2] Only with the BNO present was there a significant enhancement in the VEP amplitude in those with mTBI and VMS. The BI prisms had no significant effect. Again in both studies, the mTBI patients typically subjectively preferred the BNO only over any other test condition. Thus, with results of the two studies combined, we found that 90% of those with both mTBI and VMS showed VEP amplitude enhancement (up to 40%). This provided validity to the use of BNO in this mTBI subgroup with VMS. Furthermore, the VEP could now be used as an objective, diagnostic test to detect for the presence of mTBI per se, if VMS were also present, with 90% accuracy.

EFFECTS OF OCULOMOTOR-BASED VT IN MTBI

In this study,[4] we assessed the effect of oculomotor-based VT/vision rehabilitation in seven adults with mTBI and oculomotor-based signs (eg, saccadic inaccuracy) and symptoms of reading problems, such as skipping lines, rereading, etc. They were given 9 hours total of VT: 3 for the versional system (fixation, saccades, and simulated reading), 3 for the vergence system, and 3 for the accommodative system, all office-based working one-on-one with an optometrist; there was purposely no home therapy prescribed to control the training process. The group's mean VEP amplitude significantly increased (Figure 2), as well as in each subject to varying extents. In addition, their

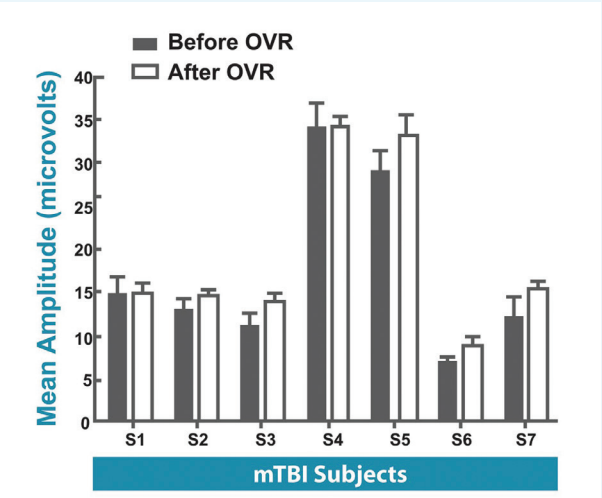

Figure 2. The group's mean VEP amplitude significantly increased.

symptoms markedly reduced and their signs improved, following the VT. In addition, with a special program created for us by Diopsys, we used the VEP to assess objectively the effect of VT on attention. It too increased significantly subsequent to the VT. Thus, the VEP provided objective documentation for multilevel, positive effects of VT in the mTBI population.

PROPOSED VEP PROTOCOL

Our ultimate goal of the above and other VEP-related studies was twofold. First, to develop an optimal VEP test protocol in both the VN and mTBI populations, which would yield the best VEP responses (ie, the largest amplitude with least variability). Second, to develop a test protocol that would differentiate objectively between the VN and mTBI groups. We succeeded in both goals, with the following suggested protocol for use in both the VN and mTBI populations.[5,6]

- Check size: 20-min arc
- Contrast: low contrast (20%) and high contrast (85%)
- Luminance: 74cd/m-square for VEP optimization; 0.22cd/m-square (using a 2.5 neutral density filter) to differentiate VN from mTBI for the latency parameter
- Trial duration: 20 seconds; 45 seconds if variability is high
- Number of trials: three to five trials for each stimulus condition. In addition, one outlier out of the three to five trials should be removed, and the mean of the remaining trials should be used and be representative of the average amplitude and latency of the VEP response

- In addition to the bulleted list here, with BNO added, those individuals with suspected mTBI and VMS can be differentiated from the VN population using the amplitude parameter.

CONCLUSION

We have been enthusiastic about our objective and direct cortically based VEP findings and protocol. We suggest the following uses: (1) pre- and postmilitary deployment, the sports season, and/or a recent possible/presumed sport-related concussion/mTBI, and visual intervention such as VT, as well as its use as a new and additional criterion for return-to-duty in the military, return-to-play in sports, and return-to-daily activities in the workplace and school settings; (2) to obtain objective as well as subjective documentation of a visual anomaly and its remediation in mTBI; (3) to use as an adjunct to assess the efficacy of a visual intervention in conjunction with conventional clinical measures of related signs and symptoms in mTBI; (4) to assess for malingering with comparison to the related VEP findings in VN, as well as in conjunction with the case history and other clinical measures in mTBI; and (5) to assess general attention in mTBI, and possibly in other diagnostic groups with attentional deficits. ■

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