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Case Report

Visual Rehabilitation in Post Mild Traumatic Brain Injury. Case-Based Review

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1. Supplementary material: treatment program

In this case report, the symptoms and visual function problems that the patient presented could not be eliminated with standard optometric treatments, such as the use of lenses or prisms. Initially, the patient was unable to relax or stimulate accommodation due to an accommodative dysfunction, being more significant in the right eye. In the presence of significant hyperopia in a mTBI, the prescription of glasses should be one of the first options for vision correction. However, the patient did not tolerate the cycloplegic prescription. She could not see clearly in far or near vision with cycloplegic refraction. The other option for managing the accommodative condition was visual therapy. The prescription was postponed until the accommodative problem had been resolved.

Although the patient presented significant endophoria in far and near vision, the ranges of negative and positive fusional vergences decreased in near vision, indicating difficulty in both convergence and divergence. For this reason, the prescription of a horizontal prism was not indicated. The presence of vertical phoria was also observed, but this was different depending on the gaze position, as can be seen in Table 2. Although vertical prisms were tried during the initial assessment, the patient indicated that she was uncomfortable with them. Due to these factors, the prescription of vertical prisms was postponed. The patient showed difficulties in changing the fixation from the right to the left gaze. The reason was likely the presence of the concomitant deviation. The patient had poor fixation in both eyes. Both the follow-ups and saccades were evaluated using the Northern State University College of Optometry (NSUCO) test. During the follow-ups, the patient presented large jumps and refixations. In addition, in the evaluation of saccadic movements, hypo- and hyper-refixations and greater imprecision movements with right eye (RE) were observed.

Therefore, the patient presented a fusional vergence dysfunction together with an accommodative infacility, as well as ocular motility dysfunction. This position was established because of the reduced ability to diverge and converge, as well as the difficulty in stimulating and relaxing accommodation.

The visual therapy program lasted for 18 sessions. The general goals of vision therapy treatment were to eliminate any diagnosed ocular motor, accommodative and binocular vision problems. Visual therapy sessions were held in the office once a week. The patient performed daily exercises at home for about 20 minutes on the other days of the week. As indicated in the Brain Injury Electronic Resource Manual prepared by the American Optometric Association, motivational elements, feedback, repetition, sensorimotor mismatch, and intermodal integration were incorporated into the different visual therapy techniques [1–3].

In the vision therapy program, three phases were established with different objectives in each of them. Table 3 details the exercises and activities performed in each of the phases. These treatment techniques have been widely described by different authors [1–5].

The objectives of the first phase were to improve the clarity of vision, the accommodative amplitude and facility and quality of fixation, binocular stability, and integration

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of ocular saccades and pursuits with balance and visuomotor performance. During this phase, accommodative exercises were performed with loose lenses and flippers. Initially, the patient could only clearly read in near vision with +/- 0.50 lenses. Each week the power of the lenses was increased, reaching accommodative jumps with lenses of +2.50/-6.00 at the end of this phase. It should be noted that in the beginning, the execution of the accommodative, ocular motility and localization exercises was worse with the RE.

When accommodation improvement was achieved in both eyes, the patient was prescribed RE: +1.50 D -0.50 D x 5° with VA of 20/16 and in the LE: +1.50 D with a VA of 20/16. With it, she observed that her symptoms diminished.

During the second phase, efforts were made to control and stabilize correct fusional alignment and accommodative convergence, improve the speed of fusion recovery, and introduce binocular accommodative facility procedures. At the beginning of the second phase, some convergence exercises had to be carried out with a vertical prism to achieve the fusion of the images. Both the fusional convergence and divergence ranges were trained.

In the third phase, emphasis was placed on integration of accommodation and binocular vision. Accommodation, vergences and precision of saccadic and follow-up movements were worked on jointly. On the other hand, fusion exercises were performed in different gaze positions.

Eighteen visits were required to complete the optometric vision therapy program. On reassessment, the patient reported an improvement in symptoms; she did not report headaches, eyestrain, or pain and the decrease in visual field had disappeared. She felt more comfortable with the current glasses' prescription than without them. She can perform near vision tasks without difficulty. The comparison of the results of the examinations before and after vision therapy are summarized in Table 1 of the article. An improvement is observed in all the optometric parameters analysed.

Table S1. List of exercises performed during the three phases of the vision therapy.

PHASE I	**Fixation, saccadic and tracking exercises** **Rotator** **Visionary software with eye-tracker (peripheral vision and ocular motility exercises)** **Macdonald card** **Hand-eye coordinationeExercises** **Hart chart** **Loose lens accommodative rock** **Spatial localization** **Brock string** **Tondel arrows** **Barrel card**
PHASE II	**Binocular accommodative facility with polarized bar reader** **Lifesaver cards** **Aperture rule** **Brock string in different positions of gaze** **Fusion cards** **Visionary software (convergence, divergence and ocular motility exercises)** **Horizontal and vertical loose prisms.** **Variable tranaglyph (convergence and divergence)** **Fixed horizontal and vertical demands anaglyph** **Convergence in far vision** **Spatial localization activities** **Monocular prism saccades**
PHASE III	**Fixation, saccadic and tracking exercises with prisms BI/BO** **Aperture rule and binocular accommodative facility** **Variable tranaglyph jump facility, with the addition of +/-2.00 flip lenses** **Vertical tranaglyph** **Lifesaver cards jump facility, with the addition of +/-2.00 flip lenses** **Random dot stereograms with loose prism jump facility**

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