ORIGINAL ARTICLE

Prevalence of esophoria in concussed patients

Barry Tannen a,∗, Kalynn Good b, Kenneth J. Ciuffreda c, Kelsey J. Moore d

a Private Practice, EyeCare Professionals, PC, Hamilton Square, NJ, United States
b Private Practice, Costa Mesa, CA 92626, United States
c SUNY/State College of Optometry, New York, NY, United States
d Vision Therapy and Neuro-optometric Rehabilitation, EyeCare Professionals, PC, Hamilton Square, NJ, United States

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Concussion; Esophoria; Convergence excess; Optometry; Post-concussion syndrome

Abstract
Purpose: To assess the prevalence of esophoria at near in concussed patients in a neuro-optometric private practice setting.
Methods: A retrospective analysis was performed involving a chart review in a neuro-optometric, private practice setting of consecutive patients with a medical diagnosis of concussion from January 1st 2016 to December 31st 2016. A total of 71 patients were included in the analysis. All received a comprehensive vision examination, with a near vision emphasis. The near horizontal phoria was assessed with the cover test and the von Graefe test.
Results: Approximately 30% of the patients with a medically based diagnosis of concussion exhibited esophoria at near, with good agreement (95%) between the two tests. Mean esophoria was 5.2 (SD = 2.8) prism diopters (pd), with a range from 2pd to 14pd of esophoria. Convergence excess was diagnosed in 23%.
Discussion: Near esophoria was found in nearly one-third of this practice-based sample of concussed patients. Thus, it was more common than typically believed to be the case. Two proposed oculomotor-based mechanisms related to these symptomatic esphoric patients included phoria decompensation and excessive accommodative vergence.

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∗ Corresponding author at: EyeCare Professionals, PC, 1777 Kuser Road, Hamilton Square, NJ 08690, United States.
E-mail address: btannenod@aol.com (B. Tannen).

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Prevalencia de la endoforia en los pacientes con conmoción

Resumen
Objetivo: Evaluar la prevalencia de la endoforia de cerca en pacientes con conmoción, en un centro privado de neuro-optometría.
Métodos: Se realizó un análisis retrospectivo, en un centro privado de neuro-optometría, con revisión de las historias de pacientes consecutivos con diagnóstico médico de conmoción desde el 1 de enero al 31 de diciembre de 2016. Se incluyó en el análisis a total de 71 pacientes. A todos ellos se les realizó un examen ocular amplio, enfatizando la visión de cerca. La foria horizontal de cerca se valoró mediante el cover test y la prueba de von Graefe.
Resultados: Aproximadamente el 30% de los pacientes con diagnóstico médico de conmoción mostraron endoforia de cerca, con buena concordancia (95%) entre las dos pruebas. La endoforia media fue de 5,2 (SD = 2,8) dioptrías prismáticas (pd), con un rango de 2pd a 14pd de endoforia. El exceso de convergencia se diagnosticó en el 23%.
Discusión: Se encontró endoforia de cerca en cerca del 25% de la muestra de pacientes con conmoción. Por tanto, esta condición clínica resultó ser más común de lo que se creía. Dos mecanismos propuestos basados en el sistema oculomotor con relación a estos pacientes endofóricos síntomaticos incluyeron descompensación de foria y exceso de vergencia acomodativa.

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exhibited exophoria at near. The mean was 8.2 (3.4) pd, with a range from 3 to 16pd.

Table 5b presents the results for the von Graefe phoria test at near. Thirty-one percent of the patients exhibited exophoria at near. The mean was 5.2 (3.4) pd, with a range from 2 to 12pd. In contrast, 69% of the patients exhibited exophoria at near. The mean was 8.0 (4.4) pd, with a range from 1 to 16pd. Of the twenty patients who showed esophoria on the near cover test, 19 (95%) also exhibited esophoria on the von Graefe phoria test at near; the remaining patient was orthophoric.

Table 6 presents the results for convergence excess (CE) versus convergence insufficiency (CI). Twenty-three percent manifested CE, whereas 77% manifested CI.

**Discussion**

The findings of the present study reveal the high prevalence (~30%) of esophoria at near, and being of considerable magnitude, in this neuro-optometric, office-based sample of individuals with concussion. The value of 30% is significantly greater than the mean value (~14%) averaged across the earlier cited investigations (Table 1), but lies in their midrange (0–58% range). Furthermore, the prevalence of esophoria at near in four of the six studies cited (i.e., in those with other
than zero values) is considerably greater (~20%) than found in a large (n = 4880) non-concussed, asymptomatic, primarily adult (~90%) clinic population (7.6% esophoria). \(^1\)

Why is there such a high prevalence of near esophoria in the present sample of concussed patients? There are at least three possibilities. First, by the process of self-selection, patients with a newly acquired esophoria at near may comprise those who do not resolve by natural recovery over time, remain visually symptomatic, and subsequently seek a comprehensive optometric vision examination, with likely visual intervention (e.g., oculomotor-based vision rehabilitation) \(^2\) to resume their vocational and avocational goals. Thus, they may eventually be examined at a specialty neuro- optometric practice. Second, and related to the first, those with prior asymptomatic, habitual near esophoria may manifest the phenomenon of phoria-based vergence "decompensation" \(^11\) as a result of their head injury. That is, their vergence adaptation mechanism \(^14\) has become impaired by the concussio(n(s), and thus their fusional motor-based compensatory ability is reduced. They now become visually symptomatic at near (e.g., intermittent diplopia, asthenopia). Third, it is likely that many of these individuals had not initially received a complete near vision evaluation, including the near phoria. If they were then referred to receive some "basic" vision therapy from either a physical or occupational therapist, the patient might have been treated for presumed esophoria and convergence insufficiency, as more commonly reported in the concussed population. \(^4\) Such therapy would then in fact be counter-productive, and furthermore likely to exacerbate the original visual symptoms at near.

The wide variation across studies is interesting. For example, in the four studies conducted in the Ciuffreda laboratory, \(^6-7\) the measurement techniques were similar and carefully performed. The test subjects (while derived at different times over a seven year period) were from the same academic clinical setting, yet the range varied from zero to fifty-eight percent having near esophoria. This variation might result from convenience sampling. It warrants further investigation over a range of large, different sample populations, such as hospital settings, the medical concussion specialist, and other optometric practices with an emphasis on the concussed patient, as different clinical settings may have unique distributions of near phoria as per their diverse referral sources. This information would help the predictive powers and diagnostic prowess of the clinical practitioner.

There may also be other reasons for these differences in studies. First, subjects in the present investigation were all in the late subacute-early chronic phase of mTBI, \(^10\) whereas those in the Ciuffreda studies \(^6-7\) were well into the chronic phase. Second, while subjects in all of the studies were visually symptomatic, type and/or severity of the visual symptoms were not controlled. The individual with the symptom of photosensitivity may differ markedly from one with intermittent blur at near. And, third, since all subjects in the present study were referred by a concussion specialist, these may represent the more symptomatically severe cases. Again, further studies in the area are warranted to unravel this complex situation.

What might be the related oculomotor mechanisms involved? There are at least two possibilities. First, as mentioned earlier, phoria-based vergence decompensation may have occurred following the concussion, thus giving rise to near visual symptomatology. \(^13\) Second, as many of these concussed patients typically concurrently manifest an accommodative insufficiency (~40%) following brain insult, \(^4\) the younger pre-presbyopic patient, as found in the present study, may attempt to exert volitional control of the accommodative system, hence in turn over-driving the accommodative vergence system due to their mutual interaction, and therefore resulting in esophoria at near and related asthenopia.

For clinicians who wish for a more systematic approach to the case history, evaluation, management, and conceptual underpinnings for the clinical care of concussion/mTBI patients, especially to "unveil" a concussion, we have included the appropriate references. \(^10,16-18\) Some critical case history questions toward this end include: what were the initial visual symptoms and their severity; how long did they last; and are there any remaining visual symptoms and related problems at today’s vision examination, and if so, what are they, and how severe are they?

In conclusion, the findings of the present investigation reveal that the presence of esophoria at near in the concussed individual may be more common than typically believed to be the case, especially based on the earlier studies (Table 1). Thus, the near phoria must be carefully and fully evaluated by the clinician, as its presence has important ramifications diagnostically, prognostically, and therapeutically in the concussed individual.

### Conflicts of interest

The authors have no conflicts of interest to declare.

### References


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