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Review Paper: Neuro-Optometry, Neuro-Optometrist, and Neuro-Optometric Rehabilitative Implications

Ali Nouraeinejad[1*]

1. Department of Optometry and Vision Sciences, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

The area of neuro-optometry, a subspecialty of optometry, has started a long time ago and continued to serve patients with neurological dysfunctions of the visual system through various methods and applications. The efficiency of neuro-optometric rehabilitation has been proved by a wealth of scientific presentations and publications in the area of neuroscience. However, this subspecialty of optometry has not yet been appreciated and recognized in many regions of the world. This scientific article outlines neuro-optometry, neuro-optometrist's duties, and neuro-optometric rehabilitative implications in order to highlight the importance of neuro-optometric rehabilitation, to shed a light on one of the missing responsibilities of optometrists in the area of neuroscience, to present the significance of references and sources worked in this area of science, and to define relevant duties for optometrists who wish to work in this sector.

1. Introduction

Within the profession of optometry, a group of optometrists are trained and practiced in neuro-rehabilitation of vision dysfunctions, binocularity, focusing, visual tracking, visual processing problems, neurological related visual problems and visual deficits caused by physical disabilities, traumatic brain injuries, and other neurological insults [1]. Since no sensory system provides more neurosensory input to the brain than vision [2-8], optometrists should be responsible and best educated to render this area of care referred to as neuro-optometric rehabilitation [1-3, 9-12].

The specialty of neuro-optometry has come about a long time ago and continued to serve patients suffering from neurological dysfunctions of the visual system [2, 3, 9, 11, 12-24]. However, neuro-optometric rehabilitation has still been overlooked at some regions in the world, including the Middle East countries, such as Iran. To the best of the author's knowledge, this is the first scientific article related to neuro-optometry, neuro-optometrist, and neuro-optometric rehabilitation published in the

*** Corresponding Author:**
Ali Nouraeinejad, PhD.
Address: *Department of Optometry and Vision Sciences, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.*
Tel: *+98 (21) 77685128*
E-mail: *alinouraeinejad@yahoo.com*

Middle East, including Iran. This may come as a surprise if one makes a survey related to this topic in this region.

The author conducted a survey in Iran, in November 2017 and surprisingly none of the surveyed optometrists (n=100), neuro-ophthalmologists (n=10), and neurologists (n=20) knew anything about the terms "neuro-optometry", "neuro-optometrist", and "neuro-optometric rehabilitation". This article reviews neuro-optometric rehabilitative prospects in order to fill this gap in the practice of optometry.

2. Neuro-Optometric Rehabilitative Philosophy

Neuro-optometric therapy is a process for the rehabilitation of visual/perceptual/cognitive/motor and/or neural disorders [1]. Neuro-optometric rehabilitation provides a comprehensive version of routine optometric management techniques through integrating fundamentals of neuroscience engaging top-down processing visual-motor and perceptual learning related to and characterized by the underlying visual/neural system plasticity in humans [1, 12, 20, 21, 25-32].

Neuro-optometric rehabilitation aims to treat ocular motor, accommodative, binocular vision disorders; to augment the rapidity, ability, and facility of visual processing and intermodal integration channels, and to incorporate multisensory inputs and outputs [1, 12, 22]. Therefore, neuro-optometry is a specialized discipline of optometry, which deals with the oculomotor, accommodative, visuomotor, binocular, vestibular, perceptual/visual information processing, and particular ocular/neurological sequelae of the acquired brain injury [1-3, 22-24].

The efficacy of neuro-optometric rehabilitation has been proved over a range of neurological related visual problems through a variety of clinical and experimental methods. For a detailed review, refer to Nouraeinejad [1].

3. Neuro-Optometrists

Neuro-optometrists are aware of the neural associations between vestibular, tactile, proprioceptive, auditory systems, and vision and this knowledge should be learned by other optometrists who would like to practice neuro-optometric rehabilitation [1, 10, 33]. In-depth knowledge of the central nervous system is particularly valuable in the application of vision therapy. Vision therapy affects these neural networks to ultimately improve areas of neural processing within the system [1, 12, 33-40].

Neuro-optometrists learn in a medical setting and gain substantial experience in diagnosis, management, and treatment of a broad range of neuro-visual disorders resulting from brain injury, systemic disease, neurological insults, and degenerative conditions. They use research-based procedures to precisely diagnose the specific deficit and then manage the situation to the perfection. Neuro-visual difficulties are extremely multifaceted and require the care of a well-qualified expert, such as a trained neuro-optometrist [1]. Neuro-optometrists should be aware of the prescribed systemic and local medications and their side effects in patients with neurological disorders, such as traumatic brain injury as this group of patients may often need pharmacological interventions for their disease manifestations [41].

When applying vision therapies in the patients with neurological disorders, it should be kept in mind that such patients may have other complications secondary to their neurological diseases, such as induced memory problems, fatigue, depression, and overall physical health issues [1, 6]. Therefore, neuro-optometrists are part of an interdisciplinary group of practitioners and scientists devoted to serve patients with physical or cognitive disabilities due to neurological disorders with a comprehensive ocular health examination and finest neuro-visual rehabilitative instructions, facilities, resources, and services in order to improve the patient's quality of life. The neuro-visual rehabilitation combines the art and science of neuro-optometric rehabilitation, with special emphasize on treatment options designed to optimize visual-motor, visual-perceptual, and visual information processing dysfunction in neurologically affected people [1].

4. Neuro-Optometrists Are to be Involved in Interdisciplinary Approaches

Considering neuro-optometrist's comprehension of and background knowledge in sensorimotor visual function and its relations with the somatosensory system, as well as the central and peripheral vestibular apparatus, it is wise to include neuro-optometrists in the interprofessional health care team where patients with neurological disorders are managed [1, 42]. This logical action will result in more timely and complimentary outcomes for patients with neurological symptoms [42].

It is very important to recognize that all neuro-optometric rehabilitative interventions are to engage in interdisciplinary approaches and require a team of experts within their areas of expertise and thus other related specialties should be involved and routinely screen pa-

tients' functions [1-3, 19, 20, 22, 24, 42-62]. Otherwise, neuro-optometric rehabilitative credibility is questioned [1]. The utmost objective of interdisciplinary rehabilitative team, where neuro-optometrists are part of the team [1-3, 19, 20, 22, 24, 42-62] is to return the patient to his/her healthy, dynamic, energetic, active, and independent daily life [1, 19, 20, 22, 62].

5. Neuro-Optometric Rehabilitative Implications

There are many fairly frequent situations in clinical practice where a referral to or a consult with a neuro-optometrist may be required. The most important conditions include concussion/traumatic brain injury, progressive neurological impairments, strabismus, and patients who avoid particular vision-related conditions [1]. One of the key points is that some of these injuries are hardly ever observed on magnetic resonance imaging (MRI) scans. So, the condition seems "normal" to everyone except the patient [1].

Visual rehabilitation is also required in special circumstances, such as stroke, birth injury, brain damage, head injury, whiplash, hemianopsia, cerebral palsy, cranial nerve palsies, nystagmus, cerebrovascular accident, traumatic visual acuity loss, oculomotor dysfunction, motion sickness, neurological disease, developmental delays, visual perceptual deficits, visual motor deficits, cognitive deficits, attention deficit disorders, autism spectrum disorders, stress-related visual problems, sports vision, visual-spatial dysfunction, vision-related dizziness and balance problems, computer vision syndrome, and learning-related vision problems (e.g. learning disabilities, dyslexia, reading and tracking problems) [1]. These visual dysfunctions can be noticeable as psychological sequelae, such as anxiety, panic disorders, and spatial dysfunctions and disorientation disturbing balance and posture [1]. Furthermore, low vision, binocular vision anomalies, accommodative dysfunctions, convergence and/or accommodation paresis/paralysis, and amblyopia also benefit from a neuro-optometric rehabilitative approach [1].

Patients with progressive neurological impairments, such as Parkinson disease, Alzheimer disease, and multiple sclerosis can have vision-related functional deficits that involve eye movements, mobility, perception, speed of processing and cognition. They also justify a neuro-optometric consult to see if they can receive assistance from neuro-optometric rehabilitation that may aid expanding the connectivity in their impaired brain areas [1].

Apart from any physical or structural damage to the nerves innervating the extraocular muscles (EOMs) or the EOMs themselves, there may be an abnormal adaptation where the brain does not precisely regulate the EOMs where to look. This is another situation where it is absolutely considered a neuro-optometric referral before advising for strabismus surgery [1].

There are other patients who may simply cope with functional deficits by basically avoiding the activity that is inconvenient. For instance, a patient who is experiencing diplopia at near sight may just stop reading books or an individual with a neuro-sensory deficit may avoid crowds. These patients may gain beneficial results from a neuro-rehabilitative evaluation to rule out vision as the original cause and to broaden their chances to enjoy these activities. This is because vision is simply learned and developed all the way through experience [1].

6. Mild Traumatic Brain Injury as One of the Implications

Mild traumatic brain injury (mTBI) or concussion, is the most common form of traumatic brain injury [63]. Mild TBI, which is a growing concern nationwide and worldwide, is prevalent in all age groups due to injuries incurred at work, sports, automobile accidents, military events, industrial accidents or general slip and fall accidents. The majority of these people will require neuro-optometric care due to the high incidence of visual disorders in them [1, 40].

Traumatic brain injury (TBI) leads to a group of various deficits of sensory, motor, perceptual, linguistic, behavioral, attentional, cognitive, and psychological nature (e.g. posttraumatic stress disorder) [64, 65]. TBI, even of the mild category, can result in diffuse neurological destructions in many systems in the body [66]. Coordination of sensory input from the visual, vestibular, and somatosensory neuro-paths is imperative to achieve appropriate balance and stabilization in the visual environment in the real world [12, 66]. This coordination of systems is probably disrupted in TBI, causing visual symptoms and complaints of dizziness and imbalance by the patient [12, 66].

Patients who have experienced concussion, characterized as mTBI, may go on experiencing severe visual processing-related motion sickness or photosensitivity in spite of being "cleared" to return to work, school or sports. In this situation, a neuro-optometric evaluation can be helpful to resolve symptoms and make sure that

there are no residual functional eye-related problems [1, 9, 11, 12, 20, 22, 67].

The identification of a concussion is decisive in many sports, such as football and hockey, where such judgments are regularly made quickly on the sidelines based on simple verbal query and/or gross visual observation of the player [68]. Vestibular and ocular motor impairments have been acknowledged in individuals with sport-related concussions with a myriad of cognitive, physical, emotional, somatic, and sleep-related symptoms and impairments [12, 20, 69-75] and this has made great advances for a tentative sideline concussion assessment [68]. If not identified appropriately, it could result in a subsequent concussion in the same game, with potentially longer-term unpleasant results [68]. This highlights an imperative requirement of an interdisciplinary approach to the assessment and management of these individuals. There is compelling evidence that neuro-optometric rehabilitation quickens post-concussion syndrome recovery in professional athletes. For a detailed review, refer to Nouraeinejad [1].

6.1. Visual dysfunction after mTBI

Visual dysfunctions are underestimated in patients with acquired brain injuries [8]. This is basically due to the fact that not all tests of the visual system are performed in a routine eye examination and ordinary short eye examinations fail to reveal declining ability and fatigue as well as the dysfunction in all aspects of the visual system [1].

The visual system can be harmfully affected in 15% to 90% of patients with even a single concussion/mTBI [6, 8, 22, 32, 52, 55, 61, 68, 76-87]. A concussion, as mTBI, can result in both short- and long-term signs and symptoms of the visual system [1, 52, 76, 77, 80, 83, 87-93]. In addition, since the first concussion increases the likelihood of subsequent ones [94] possibly owed to reduced attention capacity, impaired vigilance, probable concurrent dizziness and vestibular difficulties, the neuro-optometric assessment can be critical [12, 68]. Visual dysfunction after mTBI can disrupt every aspect of vision caused by damage to the afferent visual pathways, efferent visual pathways, and visual association areas [1].

6.2. Management of patients with mTBI

As mentioned earlier, the management of patients with mTBI should be carried out through interdisciplinary approaches, requiring a team of medical and non-medical experts [1-3, 19, 20, 22, 24, 42-62, 95]. Otherwise, the patient will be left in limbo, prolonged uncertainty or neglect [1]. A focused checklist on TBI symptoms is essential to establish the extent of visual dysfunctions and their changes over time as the follow up continues [1, 40]. The TBI patient may come along to the neuro-optometrist with symptoms, such as headache, dizziness, and even blurred vision that may be discharged as stress related [40, 95].

Although the medical care is primarily focused on life-threatening issues, it is vital to deal with the visual symptoms that can influence patients' quality of life (QOL) and activities of daily living [8, 12, 20, 22, 24, 61, 62, 67, 76, 96-99]. This highlights the importance of the associated optometric neuro-therapeutic and neuro-rehabilitative interventions in this group due to the high frequency of visual dysfunctions, especially accommodative and vergence deficits in the TBI subgroup and strabismus and cranial nerve palsies in the cerebrovascular accident (CVA) subgroup [1, 76].

Conceptual models of optometric vision care in mTBI have been introduced in order to include not only basic optometric examination and ocular motor assessment but also non-ocular motor problems and non-vision-based difficulties [55, 100]. Applying such models will provide comprehensive and up to date care for these patients, outlining a broad approach to the identification and management of the patients with mTBI [55, 98, 100] and assisting in comprehension and implementation of practice guidelines in an interprofessional setting [55]. Neuro-optometric rehabilitation has been shown to recover many problems of the patients with TBI. For a detailed review, refer to Nouraeinejad [1].

7. Conclusion

The concept that the presence of an oculomotor dysfunction may negatively affect the progress of brain injury rehabilitation is well established and this thus confirms the significance of neuro-optometric rehabilitation in this group of patients. The role of the neuro-optometrist as a key member of the interdisciplinary, rehabilitative team is indispensable to improve the overall quality of life in patients with neurological related visual symptoms.

Unless the neuro-optometrist is aware of the diverse visual signs and symptoms of patients with neurological disorders, such as mTBI, the brain injury related visual deficits will remain undetected. Although a primary care optometrist is well-educated in diagnosis and treatment of common vision problems, such as refractive errors and ocular pathology, the symptoms of patients with neurological disorders are more linked to visual spatial

and visual processing disorders that call for at least basic knowledge of neuroscience, neurology and its associated visual disorders.

Through this extremely brief but concise and comprehensive introductory review, the author has tried to explain his own intellectual philosophy and hopes that medical professionals, especially optometrists, ophthalmologists, and neurologists realize how much more can be accomplished in the care of patients with neurological disorders. Well, let's hope so.

Ethical Considerations

Compliance with ethical guidelines

This scientific article has included review and original based materials as well as the author's own intellectual original philosophy. However, the ethical guidelines have been respected.

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Conflict of interest

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