Learning Difficulties Related to Convergence Insufficiency: An Updated Literature Review

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Background and Significance

Learning disabilities and disorders affects usually the ability to realize or utilize the spoken or written languages, perform the mathematical calculations, movements, or attention. although, learning disorders occur among young children, the disabilities are usually not recognized until the school or pre-school age. (Mather and Gregg, 2006). Vision is one of the essential factors in the learning process. Near activities are visually demanding tasks that could become difficult and uncomfortable and could be related to ocular symptoms like eye strain, ocular fatigue, text instability and movement, blur vision, lake of focus and concentration, sometime could lead to double vision (Sheppard and Wolffsohn, 2018). The learning process depends on two visual system components. The first one related to the visual capacity including the basic visual physiological processes of visual acuity (refractive error), vergence, ocular motility and accommodation. The second one associated to the visual information processing (neurological) including higher brain functions, language, attention and auditory systems (Chieyeko Tsuchitani., et al. 2020).

People usually use both of their eyes when they read; from an optometrist's conception, the decrease the reading ability or learning disabilities could be associated with poor visual acuity, presence of binocular vision anomalies , or ocular diseases.. Recently, studies have shown that providing the visual and orthoptic training of near visual skills such as convergence, divergence, and accommodation facility could promote the level of visual skills and therefore could decrease the symptoms associated with this issues (Karande and Agarwal, 2017).

Near activities such as reading and writing are visually demanding tasks leading to difficult and uncomfortable feelings even when the person has a good visual acuity and normal binocular vision. Students who spend most of their time reading and writing tasks reported visual discomfort associated with performing tasks near distances. The presence of symptoms potentiates a decrease in visual performance and affects school performance, contributing to decreased life quality. The increase in digital devices, especially during the Covid-19 pandemic, has contributed to increasing this type of complaint (Nunes., et al. 2020). All of these complications indicate that convergence insufficiency becomes a public health issue, in particular during the Covid-19 pandemic (Mon-López., et al. 2020).

Any defect in the visual efficiency aspect can affect the reading or writing and Comprehension; for example, if the student has poor VA will face Difficulty in distance vision, and if there is any binocular vision problem, he/she will complain of eye discomfort, headache blurry vision and maybe double vision and all of these symptoms may lead to low academic achievement and also disinterest and lacking motivation for learning. Nowadays, with the covid-19 epidemic and the immediate need for distance learning using a computer and smartphones, students need greater visual

efficiency demand (Mon-López., *et al.* 2020). Through the present review, we will focus on one of the most visual-related disorders that could affect the students' performance and capacity to learn, which is convergence insufficiency.

Convergence insufficiency (CI) is a common binocular vision disorder characterized by hardness of maintaining fusion during perform the near work and looking to the near targets, and this is usually due to reduced ocular ability to converge on near targets. (Clark and Clark, 2015). CI is often associated with various symptoms, including visual discomfort such as eyestrain, headaches, intermittent blurred vision, intermittent diplopia, sleepiness, rubbing, closing or covering one eye, eyes feel tired, eyes feel uncomfortable, eyes feel sore, and pulling feeling. Also, symptoms related to reading and working up close such as words appear to move, jump, swim, or float, frequent Loss of place, getting fatigued quickly, re-reading the same line, reading slowly, Difficulty concentrating, trouble remembering what was read, Loss of orientation in the text during reading (Ma., *et al.* 2019).

Epidemiology of convergence insufficiency

Several studies were conducted to estimate the prevalence of convergence insufficiency. The prevalence of convergence of insufficiency was varied depending on the country, method of diagnosis, study design, and the target population. The table below shows the prevalence of CI according to different studies.

Study title	Author/Reference	Country	Study design	Prevalence
The incidence and clinical characteristics of adult-onset convergence insufficiency	(Ghadban., *et al.* 2015)	USA	They retrospectively reviewed the population-based cohort.	15%
The prevalence of convergence insufficiency in Iran: a population-based study	(Hashemi., *et al.* 2017)	Iran	Cross-sectional study	5.5%
Convergence insufficiency and accommodative insufficiency in children	(Nunes., *et al.* 2020)	Portugal	Cross-sectional study	2%
Study of Prevalence of Convergence Insufficiency (CI) among 9th and 10th-grade students in Gwalior, India	(Anitha Arvind., *et al.*2014)	India	Cross-sectional study	14.4%
Convergence Insufficiency, Accommodative Insufficiency, Visual Symptoms, and Astigmatism in Tohono O'odham Students	(Davis., *et al.* 2016)	USA	3rd-8th-grade students completed the Convergence Insufficiency Symptom Survey (CISS) and binocular vision testing with correction if prescribed	6.2%
Prevalence of convergence insufficiency among secondary school students in Khartoum, Sudan	(Hassan Layali Ibrahim., *et al.*2018)	Sudan	Cross-sectional study	5.5%
Accommodative and binocular dysfunctions: prevalence in a randomized sample of university students	(García-Muñoz., *et al.* 2016)	Spain	Cross-sectional study	3.4%

Table 1

Recent diagnostic techniques

Convergence insufficiency usually diagnosed by the ophthalmologists, the optometrists or the orthoptist and vision therapists. After obtaining the patient history, chief complains, and measuring the binocular vision parameters, the recent studies suggested a guideline to diagnose the patients with convergence insufficiency depending on the patient's symptoms, and signs as following (Sanitha, S., *et al.* 2015).

Symptoms of CI including

- Headaches: usually occur after long time of reading and writing or doing near work and due to sustained effort to increase fusional convergence.

- Asthenopia.
- Difficulty with reading often includes a complaint of intermittent blurring of words, print moving on a page.
- Sleepiness.

Signs of CI include

- Exophoria is greater at near than at a distance.
- Receded NPC. (break at 6 cm or more).

Moon., *et al.* reported that the NPC test has diagnostic validity for screening subjects with CI signs from not only normal binocular vision but also non-CI with Accommodative disorder and other binocular vision disorders (Moon., *et al.* 2020).

Low AC/A ratio (<3:1).

Reduced positive fusional vergence (PFV) (lower than Sheard's Criterion)

Sheard's rule suggest that the fusional reserve blur point have to be at least twice the size of the phoria. Sheard's criterion works best for exophoric cases so that the PFR to blur should be at least twice the size of the exophoria for it to be compensated (Scheiman M., *et al.* 2015).

Convergence insufficiency may be associated with an accommodative excess. In this case, besides the above-mentioned sign, the patient will have an abnormal Accommodative facility test (difficulties with the positive lenses in the binocular facility test). And The lag of accommodation will have a low or negative value (Sanitha, S., *et al.* 2020).

New treatment approaches

The goal of the CI management is to reduce the signs and symptoms by normalizing the accommodative and vergence systems, and that will positively affect the learning process by reducing barriers to improved academic performance Interactions by the following treatment approaches:

Correction of any significant refractive error except the following

For Low degrees of myopia, it is better to monitor the refractive error during vision therapy because it could be induced due to CI. For Hyperopia, partial correction is better than full correction due to significant hyperopia correction can lead to an increase in the degree of the exophoria. It will result in increased demand on already inadequate PFV and may exacerbate patient's symptoms (Moon., *et al.* 2020).

For relieving symptoms temporarily during reading or writing, we can prescribe base on prism spectacle.

The amount of prism prescribed is based on the minimum amount necessary to meet Sheard's criterion: Prism to be prescribed = 2/3 phoria – 1/3 compensating fusional vergence (Sanitha, S., *et al.* 2020).

Vision therapy

Recent studies indicate that Office-based vergence therapy (OBVT) with home reinforcement is the most effective treatment for symptomatic CI in children. OBVT, as documented in the literature, follows a weekly, hour-long office visit practicing 4 to 5 different procedures with a trained therapist. Procedures commonly used in OBVT include Brock strings, barrel cards, vectograms, Life-Saver free-space fusion cards, and eccentric circles free-space fusion cards. After the visit, a handout is generally provided to the patient with instructions for home reinforcement procedures. Typical home reinforcement includes multiple procedures to be performed at home for 15 minutes per day, five times per week (Goering, M., *et al.* 2020).