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REVIEW ARTICLE

CONVERGENCE INSUFFICIENCY

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Abstract

Introduction: Convergence insufficiency is a common disorder of binocular vision characterized by difficulty in establishing near motor fusion. This condition affects approximately 7.5 percent of the population.

Objectives: To present the modern attitudes in diagnostic-therapeutic modalities and follow-up of patients with this bulbomotor entity.

Materials and Methods: When preparing this literature review, two large databases of relevant studies were accessed: PubMed and GoogleScholar. By entering the keywords: convergence insufficiency, etiology, clinical picture, treatment. Large number of papers were received, out of which 25 were selected for the preparation of this paper.

Conclusion: Convergence insufficiency is a frequent disorder in ocular motility that primarily affects the young population. Characteristic symptoms such as: eye strain, horizontal diplopia, asthenopia, headaches, etc. are essential for recognizing this diagnosis, which can be the cause of reduced intellectual performance and impaired quality of life.

Key Words: *clinical picture, convergence insufficiency, etiology, treatment.*

Introduction

Convergence insufficiency (CI) is a common ocular motility disorder characterized by an insufficient amount of convergence required to achieve and maintain clear, binocular vision at near fixation. It was first described in 1855 by Graefe, and later investigated in detail by Duane (1). The classic clinical picture of this condition is characterized by: 1. Exophoria that is more pronounced at near than at distance, 2. Displacement of the near point of convergence to a greater distance, 3. Decreased positive fusional convergence. According to research by Mohney et al. and Govindan et al. this condition is estimated to be present between 10 and 20% of children with exodeviation. The same sources indicate that every year CI has a representation of 64 new cases per 100,000 in youth up to 19 years of age, while the prevalence in adults ranges between 3.4-7.7% (2,3).

It is the most often an idiopathic condition in the young adult population that is probably due to a congenital deficiency or an acquired imbalance of vergence bulbar movements. The center for

these movements has long been thought to be located in the reticular formation of the midbrain. At this level, there are neurons that give the convergence signal immediately before and during the convergent movement itself. Recently, it has been known that specific centers located at the level of the pons have an active role in the fast and slow parts of the vergence movement (4,5). Convergence likely consists of a biphasic response to a change in stimulus position. The first phase is fast and with short latency, triggered by a rapidly moving stimulus or occurring during sudden changes in fixation. This phase is followed by slow vergence movements with somewhat longer latency. The second stage is under the control of visual feedback and is due to the joint action of fusion and accommodative convergence. The first stage is the one that can be influenced by exercises (6).

Apart from idiopathic, CI is also associated with number of other diseases and conditions such as: myasthenia gravis, intoxications, infections, inflammations, neurodegenerative diseases (Parkinson's disease, progressive supranuclear palsy and Huntington's chorea), Parinaud syndrome, head trauma and intracranial ischemia (7-9).

Although it can be asymptomatic, people suffering from this disorder of oculomotor mobility show symptoms such as: eye strain, blurred vision or horizontal diplopia, asthenopia, reduced concentration, difficulties in performing close-up activities, headaches (mostly after long hours of reading, in the frontal or periocular region), all this leads to reduced academic performance and impairment of the quality of life. The most often, the symptomatology is more pronounced during stress, illness, or lack of sleep (10).

Materials and Methods

To prepare this literature review, a search of PubMed and GoogleScholar databases for relevant studies published in journals between 1944 and 2023 was performed. The following Key Words were used in the search: convergence insufficiency, etiology, clinical picture, diagnostic criteria and treatment. From the received publications, 25 were selected which were included in the development of this paper, and which we considered to reflect the modern attitudes towards the management of this common ophthalmological condition the most adequately.

Results and Discussion

The definitive diagnosis of CI is a set of anamnestic data and clinical evaluation that form the diagnostic criteria for establishing this diagnosis:

1. Exophoria greater near than far by at least 4 prism diopters,
2. Displaced near point of convergence (NPC- near point of convergence) of 6cm or more,
3. Insufficient positive fusional vergence (PFV- Positive Fusional Vergence),
4. Symptoms, according to the Convergence Insufficiency Symptom Survey (CISS-Convergence Insufficiency Symptom Survey).

Assessment of Phoria

Phorias represent a natural ocular alignment that is the best evaluated by performing an alternating Cover test and neutralizing eye movements, through which their size is determined. Phorias can be temporally deviated ocular alignment-exophoria or nasally deviated alignment-esophoria. The most of patients with CI have exophoria at near, while orthophoria or mild exophoria at distance. In addition to the Cover test, the investigation of phoria can also be done with the Von Graefe technique or the modified Thorington technique. (11,12)

Estimation of the Near Point of Convergence

The nearest point of convergence measures the magnitude of convergence by tracking the target to the nose. The size is estimated either subjectively when the patient gives data about the occurrence of diplopia, or objectively when the examiner notices a deviation of the subject's eyes outwards. This value is reported in cm and is marked as the convergence break point. A normal NPC value is around 8-10cm, a distance less than 5cm is excessive, and greater than 10 is insufficient. NPC is the most commonly present abnormality and the most commonly used single diagnostic criterion for investigating CI. To determine the NPC can be used: an adjustable target or RAF-ruler, a pen with a lamp or a pen with a lamp and red-green glasses, as well as Jumb convergence (12,13).

Positive Fusional Vergence

PFV is the amount of convergence required to maintain binocular near fusion and the amount required to overcome bulbar temporal disparity. To determine it, the patient is given to look at Snellen's signs, and prisms are gradually added in front of him. The moment when fusion of the images into one is no longer possible, diplopia will occur, and this moment is known as the breaking point. The amount of prism added to cause diplopia is a measure of the amount of fusional convergence. By gradually reducing the size of the prism, fusion can be re-established, and this point is known as the fusion recovery point which is also an indicator of fusion potential. Patients with CI have low fusion amplitude. The determination can be performed by changing the size of prisms in a phoropter 2PD per second or by using a prism bar (12,14).

Convergence Insufficiency Symptom Survey

The CISS is a survey that aims to quantify the severity of a patient's symptoms, based on 15 CI - related anamnestic questions. When performing the CISS, the questions are read aloud, and the respondent chooses one of 5 possible answers that are scored from 0 to 4, based on the frequency of symptoms (never, rarely, sometimes, often or always). At the end, all the points are added up to give the final result. A score of 16 or more is specific for patients with CI, the maximum possible score in this test is 60 (15,16).

Another additional criterion when examining a patient for CI can be the ratio between accommodation-convergence/ accommodation (AC/A ratio). This ratio is usually determined by the heterophoria method using a mathematical formula. It depends on the sum between the interpupillary distance and the difference between the near and far prismatic deviation at fixation

at 6m and 33cm. A normal AC/C ratio is between 3:1 and 5:1, while in CI patients, this ratio is < 2:1 (17). Other ways to determine this ratio is by using the addition lens, haploscopic method, Von Graefe or modified Thorington method.
In addition to these criteria, the best-corrected visual acuity for near and distance, as well as with refractometric tests subjective and with cycloplegia, are also determined in the course of the overall evaluation for CI patients. In certain situations, tests for stereoscopic near vision are also used, such as: TNO, Randot dot, Worth four-dot test, etc.

Differential Diagnosis

Before approaching any CI treatment, the patient should be properly examined, anamnestically and clinically followed in order to rule out possible differential diagnostic challenges. Idiopathic CI should be differentially diagnosed from other diseases of oculomotor motility, especially from: exotropia (basic or acquired), diplopia, internuclear ophthalmoplegia, oculomotor paralysis, thyroid ophthalmic disease and myasthenia gravis (18).

Management and Treatment

Before starting any treatment, the patient should be adequately corrected for any refractive anomaly. It should be advised that work at close range be in a well-lit room with adequate rest periods. Orthoptic therapy is the first line of treatment for CI. The idea is to model the plasticity of the fusional reflex convergence system through exercises. Today there are various types of exercises and techniques used in daily clinical practice to treat CI. From a didactic point of view, they are divided into passive and active techniques, depending on the way they control CI. The most commonly used passive treatment of CI is using reading glasses with a prism, while active techniques include pencil exercises at home, various visual techniques at home or in the office, exercises with prisms, stereograms, etc. (19,20).
Conventional therapeutic modalities for convergence include home-based pencil push-ups, jump convergence exercises, stereograms and convergence cards (variable and non-variable tranaglyphs, variable vectograms), as well as prism exercises. In a more recent period, a program for computerized convergence exercises is also used, which is based on a random dot stereogram.
Contemporary treatment attitudes indicate that office treatment of CI supported by home exercises is the first-line treatment for children with CI. According to clinical trials, this method of treatment has been shown to have a success rate of approximately 75% (21). Office part of the treatment includes 4-5 exercises, lasting one hour a day for a period of one week. Office exercises are a combination of prism, Brock string, stereograms, vectograms, fusion cards, etc. While at home, the patient continues with convergence strengthening procedures such as pencil exercises (pencil push-ups) 5 times a week for fifteen minutes. In this way, the treatment of CI is classically carried out, the patient is monitored on a weekly basis or every few weeks depending on the current condition. Orthoptic treatment can be repeated in several sessions (22).

In refractory cases of conventional, classic therapy, the last possible but controversial option is surgical treatment. It includes recession-resection of the lateral and medial rectus respectively, especially of the non-dominant eye. It is important to note that many surgeons and ophthalmologists do not agree with this method of treatment, due to the fact that it is accompanied by a high risk of consecutive esotropia, diplopia and developing A-V syndromes postoperatively (23).

Prognosis and Monitoring

The prognosis for patients with idiopathic CI is generally good. According to the Convergence Insufficiency Treatment Trial Study Group, 73% of people who practiced appropriate therapy for more than 12 weeks had significant improvements in vergence movements (24). The follow-ups of patients with CI should usually be performed every 4 to 8 weeks. Patients with acquired CI due to trauma or other disease need a longer recovery period (25). Although it does not significantly impair the general health of patients, untreated CI is the cause of reduced quality of life and reduced intellectual performance.

Conclusion

Through this literature review, we tried to provide new insights and attitudes in the diagnostic and therapeutic criteria for CI management. As we have shown, it is a frequent disorder in ocular motility that primarily affects the young population. Characteristic symptoms such as: eye strain, horizontal diplopia, asthenopia, headaches, etc. are essential for recognizing this diagnosis, which can be the cause of reduced intellectual performance and impaired quality of life.

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