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Prevalence 0f Convergence Insufficiency-Review

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Abstract: Convergence insufficiency is one of the most common causes of ocular discomfort, and hence, it is of vast clinical significance.CI is a common binocular vision disorder affecting of the population in the West Bengal population. It is often associated with a host of symptoms that occur when doing near work, such as reading and computer viewing. This article reviews the existing literature on convergence insufficiency including etiology, diagnosis, and prevalence rate.

Index Terms - Convergence Insufficiency, Clinical Features, Prevalence Rate.

I. INTRODUCTION

Convergence insufficiency (CI), first described by Von Graefe in 1855 and later elaborated by Duane,[1] [2] is a common binocular vision disorder; it causes muscular asthenopia and ocular discomfort, and is therefore of considerable clinical significance.[1] Where as Scheimann et al. defined CI as a condition characterized by exophoria greater at near than at distance, a receded near point of convergence (NPC), and reduced positive fusional vergence (PFV) at near and a low AC/A ratio.[3] .In one line we can define Convergence Insufficiency is inability to obtain or/and maintain adequate binocular convergence.

CI is generally associated with symptoms such as eyestrain, blurry vision, double vision, headaches, reading related problems [4] sleepiness, poor concentration and cognitive decline shortly after beginning to read or performing other near visual activities [5] These symptoms affect the person's quality of life and lead to decreased academic, occupational and sports performance.[5] The academic demands of reading and writing tasks increase in higher grades, and thus the presence of CI becomes manifest when near visual tasks are carried out for extended periods. CI typically affects students in the secondary school grades, when students read smaller print and face increased reading demands. [6] [1] Von Noorden and Campos stated that "CI seldom becomes a clinical problem until a patient reaches the teenage years. Increased schoolwork and prolonged periods of reading may then exacerbate the characteristic symptoms." [1]

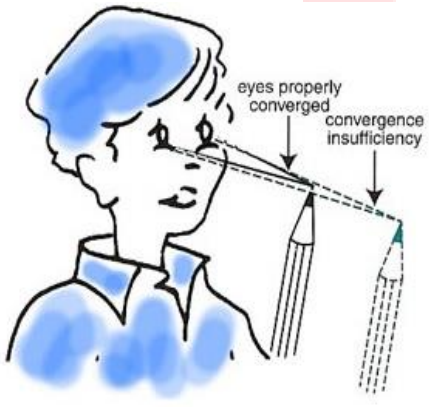


Figure 1 convergence insufficiency

Figure 2 clinical view of converging eye

II. Review on Structure and Anatomy

Extraocular Muscles And Orbital Fascia

A set of six extraocular muscles (4 recti and 2 oblique) controls the movements of each eye. Rectus muscles are Superior rectus(SR),Inferior rectus(IR),Medial rectus(MR),Lateral rectus(LR).The oblique muscles includes Superior oblique(SO) and Inferior Oblique(IO).The four rectus muscles originate from a common tendinous ring (the annulus of zinn), which is attached at the apex of the orbit encircling the optic foramina and medial part of the superior orbital fissure. The **Annulus of Zinn** appears oval on cross-section All the four recti from their origin run forward around the eyeball.

Extraocular Muscles involved in convergence

- Medial Rectus(Agonist)
- Lateral Rectus(Antagonists)
- Inferior Rectus(Synergists)

Medial Rectus

Medial rectus is the shortest but strongest of the four recti. It originates from the medial part of the **common tendinous ring**, The muscle courses anteriorly, sliding over the medial part of the eye to cross its equator and reach the anterior half of the eyeball. It then inserts onto the medial side of the eyeball, around 5 millimetres posterior to corneoscleral junction. The inserting muscle fibers pierce the fascial sheath of the eyeball (Tenon's capsule). Medial rectus muscle runs cushioned in the **periorbital fat tissue**, superior to the floor of the orbit this muscle is innervated by the **inferior branch of oculomotor nerve (CN III)**. Blood supply to medial rectus comes from the **ophthalmic artery**, a branch of the internal carotid artery. When contracting, each medial rectus muscle adducts the eyeball, i.e. pulls the eye medially. This action is important in two types of ocular movements; conjugate and disconjugate.

Conjugate movements are when both eyeballs move in the same direction. Medial rectus takes part in conjugate movements of the eyes in a **horizontal plane** (i.e. left and right), working together with lateral rectus.

- Ipsilateral medial rectus relaxes ipsilateral lateral rectus contracts. This sequence pulls the ipsilateral eye toward the desired direction.
- Contralateral medial rectus contracts, contralateral lateral rectus relaxes. This sequence pulls the contralateral eye toward the desired direction.

As lateral rectus is supplied by the abducens nerve (CN VI), the synchrony between these muscles is established by the medial longitudinal fasciculus that connects the oculomotor and abducens nuclei.

Disconjugate movements are when the eyeballs converge or diverge from the midline. When both medial recti contract, they converge the eyeballs toward the midline. Convergence is a part of the accommodation reflex, when the eyes adjust to observe a close object.

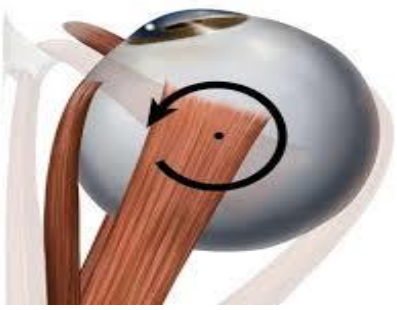


Figure 3 Medial Rectus Muscles

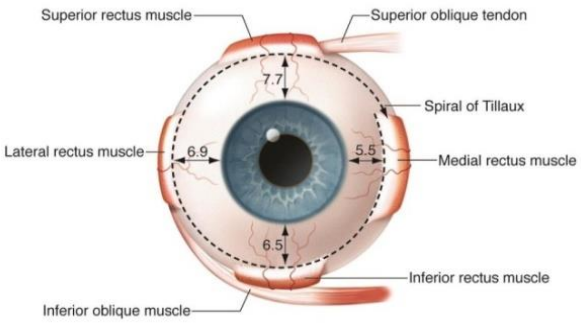
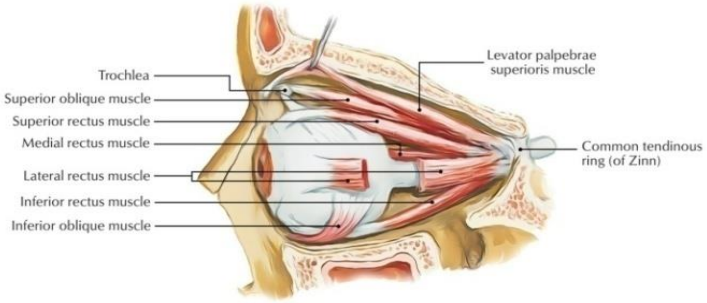


Figure 4 All Ocular Muscles And Its Distance From Limbus

Inferior Rectus

The inferior rectus muscle originates from the common tendinous ring, and goes on to attach at the lower anterior surface of the eyeball.The **primary action** of the inferior rectus is depression of the eyeball, Secondary action of the inferior rectus is extortion ,Tertiary action of the inferior rectus is adduction. The inferior rectus muscle is a narrow, strap-shaped muscle of the orbit that extends over the floor of the orbit. Alike most of the extraocular muscles, the inferior rectus muscle originates from the **common tendinous ring**, also called the **annulus of Zinn**, that is found in the posterior pole of the orbit encircling the margins of the optic the medial, lateral. these actions are exhibited with the isolated contraction of the inferior rectus muscle. The inferior rectus muscle originates from the inferior part of the common tendinous ring.

Figure 5 Inferior rectus



Figures 6 All ocular muscles

Lateral Rectus

It arises from the lateral part of the common tendinous ring and crosses the superior orbital fissure. This tendinous ring encircles the margins of the optic canal and part of the superior orbital fissure**.**The fascial sheath of the lateral rectus muscle gives off a triangular expansion called the lateral check ligament. This ligament attaches to the orbital tubercle of the zygomatic bone and serves to restrict the lateral rectus muscle and limit the abduction of the eye. The lateral rectus muscle is supplied by branches of the abducens nerve (CN VI), which enter its medial surface and provide general somatic efferent fibers. The lateral rectus muscle is supplied by the ophthalmic artery that stems from the internal carotid artery.

Conjugate Movement: The lateral rectus muscle abducts the eye and directs the gaze laterally in the horizontal plane(i.e. right to left).The lateral rectus in one eye muscle has to work in coordination with the medial rectus of the other eye, in which the medial rectus needs to relax when the lateral rectus contracts.

- Ipsilateral lateral rectus relaxes ipsilateral medial rectus contracts. This sequence pulls the ipsilateral eye toward the desired direction.
- Contralateral lateral rectus contracts, contralateral medial rectus relaxes. This sequence pulls the contralateral eye toward the desired direction.

As medial rectus is supplied by the adduction nerve (CN VI), the synchrony between these muscles is established by the medial longitudinal fasciculus that connects the oculomotor and adductant nuclei.

Figure 7 Lateral Rectus

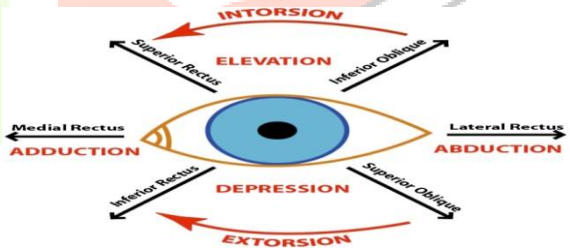


Figure 8 Functions of all Ocular Muscles

III. Clinical Features of Convergence Insufficiency

Symptoms [57]

Asthenopia- is more commonly known as eyestrain (our eyes may feel tired or irritated after focusing intensely on activity like viewing a computer screen, reading a book, for a long period of time) or ocular fatigue. Our eyes may feel irritated, sore, or tired.
Diplopia-When your eyes don't move together, you might see double. Things may look blurry.
Headache - especially on near work, was found to be the most marked symptom. [7] Occur after long periods of reading and are usually frontal or periocular due to sustained effort to increase fusionals convergence during near tasks. Eyestrain and vision issues can make your head hurt. It may also cause dizziness and motion sickness.

Difficulty reading / Near task - When we read, it might seem like words are moving around. Children might have a hard time learning how to read.

Trouble concentrating - It can be difficult to focus and pay attention. In school, children may do work slowly or avoid reading, which can affect learning.Less common symptoms include nausea, motion sickness, dizziness, panoramic headaches, and generalized fatigue.

Sign of CI [9],[10]

1. Moderate to high exophoria at near >6 ▵
2. Reduced positive fusional vergence at near ≤12/15/4 for blur, break, & recovery
3. Low AC/A ratio <3/1
4. Fails binocular accommodative facility with +2.00 D, ≤2.5 cpm
5. Low Negative Relative Accommodation ≤1.50 D
6. Exophoria at near ≥4 prism diopter (pd) greater than far
7. Insufficient fusional vergence: (i) fails Sheard's criteria or (ii) poor PFV at near ≤12 pd. Base out (BO) to blur or ≤15 pd BO break. Poor BO break was used for PFV criteria
8. Receded NPC ≥7.5 cm break and ≥10.5 cm recovery

Direct measures of PFV

- Reduced smooth vergence
- Reduced step vergence
- Reduced vergence facility

Indirect measures of PFV

- Low negative relative accommodation (NRA)
- Difficulty in clearing plus lenses during binocular accommodative facility testing
- Low values in Monocular estimation method (MEM)

Evaluation Techniques

- BCVA at distance and near
- Subjective refraction
- Cycloplegic refraction various authors have adopted different diagnostic criteria for convergence insufficiency
    - Cover Test
    - Maddox Rod(Von Graefe technique)
    - Vergence Facility Test
    - RAF Ruler(NPC)
    - Fusional Vergence
    - Stereopsis test

Estimate phoria

Most patients with CI exhibit exophoria at near and orthophoria or low exophoria at distance. Phoria measurement for near and distance is performed by:

- Cover test
- Von Graefe techniques

Cover Test

- Eye movement capacity, image formation and perception, foveal fixation in each eye, attention and cooperation are necessities for cover testing.If a patient is unable to maintain constant fixation on an accommodative target.Normal value at near - 3Δ exophoria +/- 3Δ

Figure 9 Cover Test

Figure 10 Cover Test at near

There are three types of cover test

- Direct Cover
- Cover uncover
- Alternating Cover

Von Graefe Technique

The Maddox rod is a dissociating test that will reveal and measure a phoria or a tropia. A dissociating test is a test that presents dissimilar objects for each eye to view, so that the images cannot be fused. The Maddox Rod test is most commonly used only to measure phorias. The problem with the Maddox rod test is that it can be confusing to tester, not to mention the test.

Figure 11 Maddox Rod

Figure 12 Testing through Von Graefe Technique

We might consider performing the Von Graefe technique. This test gives the same results, it is easier to remember how to perform, and it is usually faster to perform. Normal value is sc (F) L/R 5Δ eso 8Δ (FR), sc (F) 5Δ BD 8ΔBO (FR), sc (F) R\L 5Δ eso 8Δ.[13]

NPC

This test measures the distance from your eyes to where both eyes can focus without double vision. It is the point where the visual axes intersect under the maximum effort of the convergence. It is a measure of pursuit convergence. This is a standard test for convergence ability. Most of the optometrists, however, consider NPC as the main factor in making a diagnosis of convergence insufficiency. Patient is asked to maintain fixation at the target placed at 30–40 cm in the midline and the target is moved towards eyes until one of the eyes loses fixation and turns out (usually non dominant). The normal range for NPC is 8–10 cm. A distance closer than 5 cm is excessive, and NPC farther away than 10 cm is remote. [6]

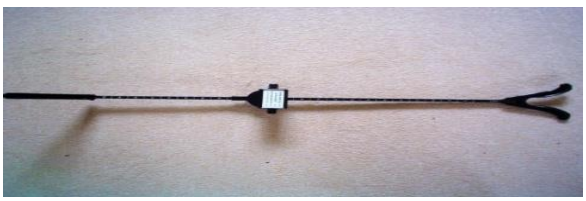


Figure 13 RAF Ruler

Figure 14 Measuring the Near Point Convergence

Fusional Vergernce

Fusional Vergence is the movement of both eyes that enables the fusion of monocular images producing binocular vision. Convergence is the disjugate movement in which both eyes rotate inwards for bifoveal single vision. Fusional convergence is a reflex produced to ensure that similar retinal images are projected onto corresponding retinal areas. Normal value ≤12/15/4 for blur, break, & recovery. [9]

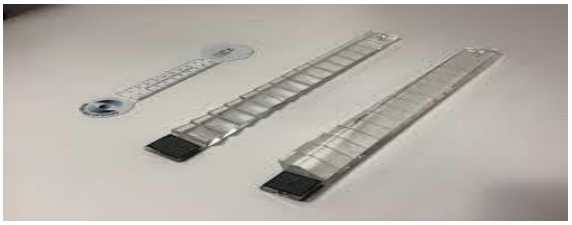


Figure 15 Prism Bar

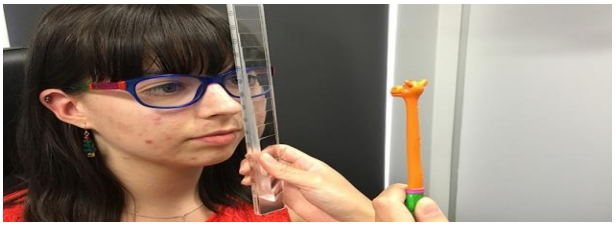


Figure 16 Measuring Fusional Vergence with Prism Bar

Vergence Facility Test

Vergence Facility testing one of the most important methods of detecting patients with binocular vision disorders. Non-strabismus binocular vision abnormalities can be improved through the use of vergence facility testing at near. The test is performed at 40 cm as the patient views a vertical 6/9 target or similar. Twelve diopter base out (BO) and three diopter base in (BI) prism are alternately placed before one eye; the patient is asked to report when the target becomes single and clear. This prism change is repeated for one minute and the clinician records the number of cycles performed during testing. Normal value 18 flips in 1 minute or 9 cycles per minute.

Figure 17 Lens Flipper

Figure 18 Testing the Vergence Facility for near

Stereopsis Tests

Stereopsis is a critical component of human vision. This slight offset causes our visual system to see an image from a slightly different perspective. The combination of these slightly different images allows the visual system to judge fine depth and create a 3-dimensional interpretation of the image. This becomes important when objects are close to one another or the task requires the visual system to provide exact information on where the body is relative to an object (thing threading a needle).The slightly different perspective each eye sees is due to images falling on slightly different points on the retina of the eye. This is termed disparity and is the critical item that is measured in a stereopsis test. Random dot stereopsis test, TNO test, Worth four-dot test,etc., can be used.

MEM(Monocular Estimated Method)

MEM (Monocular estimated method) objectively tests a patient´s accommodative response at the near working distance (usually at 40 cm). This method is valuable in the diagnosis of binocular anomalies or to predict suspected cases of vergence and/or accommodative dysfunction. It is suggested to use test in all young adults, non-presbyopes and especially patients that have a near complaint (astenophia, diplopia, blur vision). The normal values are between +0.25 D and +0.50 D. [14] All patients under age 18, adults that are in school or are complaining of fatigue with near work.

Figure 19 MEM Retinoscope

Figure 20 MEM Retinoscope And Its Slides

AC/A Ratio

Heterophoria Method:

To measure AC/A ratio,in this method,the deviation is measured with full optical correction at 6 metres distance and at 33cm distance in prism dioptres, and IPD is measured in centrimetres.then AC/A ratio is calculated from:

$$\text{AC/A ratio} = \text{IPD} + (\Delta n - \Delta d)/d$$

Where,

IPD =Interpupillary Distance in centimeterss

Δn=Deviation at 33cm or 3 diopters

Δd =Deviation at 6 m distance in prism diopters

d =The fixation distance at near in diopters

Normal value of AC/A ratio is between 3:1 and 5:1 [2] [3]

Gradient Method:

This method is based on the fact that for a given fixation distance,minus lenses placed before the eyes increase the requirement for accommodation and plus lenses relax accommodation.

Where,

$$\text{AC/A} = \Delta L - \Delta O / D$$

ΔL = deviation with lens

Δ0 = original deviation

D = power of the lens

IV. Prevalence of CI

1. A Population-based study was conducted on the prevalence of non-strabismic anomalies of binocular vision in ethnic Indians are more than two decades old. Based on indigenous normative data, the BAND (Binocular Vision Anomalies and Normative Data).In four schools, two each in rural and urban arms, 920 children in the age range of 7 to 17 years were included in the study. Prevalence of convergence insufficiency was **16.5%** and **17.6%** in the urban and rural arms, respectively.There was no gender predilection and no statistically significant differences were observed between the rural and urban arms in the prevalence of non-strabismic anomalies of binocular vision. [15]
2. In a study 2162 cases in the age group 15 to 35 years were studied for convergence to the outpatient departments with persistent headache, eyestrain (particularly for near work) and other vague complaints. It was found out that the incidence of primary convergence insufficiency out to be **7.7%** of the total attendance of the orthoptic clinic.They fails to realize that primary insufficiency of involuntary convergence is a common condition and it carries a great nuisance value. It commonly effects those who are consistently engaged in near work. [16]
3. In this cross-sectional study, 124 students of different majors of Zahedan University of Medical Sciences were randomly selected 75 female and 49 male. Asymptomatic and symptomatic subjects numbered 82 subjects (**66.1%**) and 42 subjects (**33.9%**).Symptomatic and asymptomatic subjects numbered 28 subjects (**37.3%**) and 47 subjects (**62.7%**), and in males 14 subjects (**28.5%**) and 35 subjects (**71.5%**), respectively. [17]
4. An observational study was conducted at Pondicherry with 142 patients between the age of 18 -35 years (61 males and 81 females) who came to the ophthalmology outpatient department (OPD) in a tertiary health care center. To find the relationship between convergence insufficiency and body mass ratio but the study concluded those body mass ratios have no correlation with convergence insufficiency. Difference of age between the sexes was not statistically significant the prevalence of CI between 18 and 35 years of age was found to be 27.46% which males were **33.33%** and females were 66.66%.In this study, according to the CISS questionnaire score, only **53.84%** of our patients were found symptomatic. [18]
5. In a survey of 660 cases which came for eye testing at the Ophthalmic department of the Medical College Hospital, Indore.Total number of cases who complained of headache and other symptoms 319.Total number of heterophoria cases with symptoms 34.Total number of cases of Convergence Insufficiency 22.This gives an incidence of **3.6%,** among the cases who came for eye testing. This survey shows a marked preponderance of cases, who were not suffering from any other ailment and who were thus primarily having Convergence Insufficiency. All the cases were of the 18 to 25 years age group. Females predominated, being go in number as compared to males. [7]
6. A study was performed effect of therapy among computer users having convergence insufficiency.100 people between age group of 20-35 and who worked in IT companies were enrolled in the study. They were subjected to orthoptic evaluation to establish diagnosis of convergence insufficiency 52% was male, and 48% were female. Computer vision syndrome is a well-known hazard among prolonged computer uses. It ranges as high as between 64% and 90%.Eyestrain is one of the major symptoms of computer vergence system (CVS). It is mainly due to convergence insufficiency (CI).CI is a common disorder affecting as much as **4%-6%** of the population.It is more among people doing prolonged near work such as reading, writing ,computer use. [21]
7. This is a cross-sectional study with an estimated sample size of 936 in rural and urban arms of Tamilnadu between 7-17 years age were included. The most prevalent NSBVA was convergence insufficiency (**32%** in the overall population and 69.5% among the NSBVA). [32]
8. To estimate the Prevalence of Convergence Insufficiency(CI) among 12-16 year old school children across six schools in Gwalior,M.P,India. the 818, the data collected.The findings suggest that CI (defined as suspect and definite CI) is frequent(**37.89%**) among 12-16 year old school children. The study reports that females are **1.5%** times more likely to have CI than males. [35]
9. In a study 4211 students screened, 329 (7.8%) were diagnosed with CI from three types of school. Of these 329, 173 students were male and 156 were female; there was no significant relationship between sex and CI.Standard schools had a higher prevalence of CI (**43%**) than geographic schools (**36%**) and there was a significant association between CI and the type of school. Prevalence of CI **7.5%.** It has also been reported that there is no significant difference in the prevalence of CI between adults and children. Standard schools had a higher prevalence of students with CI (**43%**) than geographic schools (**36%**). [1]
10. In this population-based cross-sectional study.To determine the distribution of near point of convergence (NPC) according to age, sex, and refractive error in a rural population. Of 3851 who were invited, 3314 participated in the study (response rate: 86.5%) prevalence of 6.4% for visual impairment, type one error of 0.05, precision of 1%, design effect of 1.5, and attrition of 10%.Female subjects comprised 56.3%, 33.4% of the subjects were illiterate. Convergence insufficiency is the commonest binocular dysfunction with a prevalence of **1–33%.**[22]
11. A cross-sectional study of first year students of the University of Benin, Benin City, Nigeria. Of the total 212 subjects, 27 (12.7%) had vergence anomaly while 185 (87.3%) did not have vergence anomaly. Thus, the prevalence of vergence anomalies among first year university students was 12.7%. This comprised of 14 (51.86%) male and 13 (48.14%) female subjects. Convergence insufficiency was the most common vergence. In terms of age, 13 (**48.1%**) had vergence dysfunction within the 19–22 years age group followed by 9 (**33.3%**) in the age group 23–26 years and 5 (**18.6%**) in the age group 15–18 years. [23]

12. A study was done in Hampyeong, a rural area of South Korea on prevalence of nonstrabismic accommodative and vergence dysfunctions among primary schoolchildren. 589 primary schoolchildren, 8–13 years old, were each given a thorough eye examination. Out of 589 participants, 168 participants (28.5%) presented with accommodative and/or binocular dysfunctions, 289 participants (49%) were classified as normal, and 132 participants (22.4%) were classified as refractive errors. Of the 168 participants with binocular dysfunctions, 53 participants (9.0%) presented with accommodative dysfunctions, 78 participants (13.2%) presented with vergence dysfunctions, and 37 participants (6.3%) had combined accommodative and vergence dysfunctions. the convergence insufficiency was the most prevalent (**10.3%**). [24]
13. A study was conducted to investigate the association between refractive error and common binocular vision and accommodative dysfunctions in Chinese adults.Prospective cross-sectional clinic-based study. The 422 screened potential participants a total of 415 eligible Chinese participants aged between 21 and 38 years, were grouped into 4 refractive error groups (emmetropia, low, moderate, and high myopia) based on the spherical equivalent power of noncycloplegic refraction. The low myopia and moderate myopia groups each comprised 107 participants, while the emmetropia and high-myopia groups only comprised of 96 and 106 participants, respectively. The 3 most common dysfunctions in this sample population were basic exophoria (10.8%), convergence insufficiency (**9.6%**), and divergence insufficiency (7.0%).The frequency of convergence insufficiency was found to be the highest in hyperopes (**12.9%**), followed by emmetropes (**4%**) and myopes (**1.6%**).In this study, the frequency of convergence insufficiency was the highest in emmetropes (**15.8%**), followed by low myopes (**12.1%**), high myopes (**6.6%**), and moderate myopes (**4.7%**). [25]
14. The study design was cross-sectional and comprised data from 1056 African high school students aged 13–18 years, who were randomly selected from 13 high schools in uMhlathuze municipality in the province of KwaZulu-Natal, South Africa. In the final sample, 403 were males and 653 were females. The prevalence of CI and REs. The prevalence of low suspect CI was **12.4%,** high suspect **6.3%,** definite **4.6%** and PCI **2.1%**, while the prevalence of REs was as follows: hyperopia **6.8%**, myopia **6.0%**, astigmatism **2.3%** and anisometropia **1.3%**. Convergence insufficiency is the most prevalent near point vergence anomaly in school-aged children. [26]
15. The prevalence of general binocular dysfunctions (nonstrabismic) for non presbyopes in the clinical population.Determined the presence and clinical implications of these conditions in a population of university students with heavy near visual demands.65 students were selected 32.3% of the subjects showed general binocular dysfunctions **7.7%** had convergence insufficiency. [27]
16. The study design was cross sectional and data was analyzed for 1201 high school students aged 13–19 years who were randomly selected from 13 high schools in uMhlathuze municipality were 476 males and 725 females. The prevalence of clinically significant convergence insufficiency (CI) was **10.3%**. [10]
17. In this cross-sectional study to examine the prevalence of convergence insufficiency in an Iranian population. 4,453 selected people, 3,132 participated in the study. The prevalence of convergence insufficiency in this study was **5.51%** (**4.78 %** in males and **5.86%** in females). [30]
18. A retrospective, population-based cohort study was done in Olmsted County, Minnesota with two hundred five cases of childhood exotropia were identified during the 10-year period prevalence of approximately **1.0%** of all children younger than 11 yrs. [29]
19. To estimate the frequency of CI and its related characteristics among 8to 12 years old children random selected from 2 optometry clinic populations. Clinic records of 620 children were randomly selected.415 children were classified as low suspect (**33%**), high suspect (**12%**), definite CI (**6%**).Clinically significant (high suspect and definite categories) was identified in **17.6%** of the children. [31]
20. To assess the validity and reliability of the revised Convergence Insufficiency Symptom Survey (CISS) in adults aged 19–30. Forty-six adults with CI and 46 adults with NBV participated in the study. The mean CISS score for the CI group was **37.3** and **11.0** for the NBV group. [32]
21. A cross-sectional study was carried out with children enrolled in the 5th and 6th school years. 372 children (192 girls) were assessed. The prevalence of definite Convergence Insufficiency (CI) in the children assessed was **2%.** A prevalence of **6-8%** could be considered if clinically significant CI (high suspect and definite categories) cases. [4]
22. A cross-sectional study, all residents over one year old in Mashhad city, in the north east of Iran. Of the 4,453 selected people, 3,132 participated in the study and finally, analyses were done with data from 2,219 individuals. The prevalence of convergence insufficiency in this study was **5.51** percent: **4.78** percent in males and **5.86** percent in females. The prevalence of myopia, emmetropia and hyperopia was respectively **12.1**, **56.9** and **31** per cent in participants with convergence insufficiency. [5]
23. To assess the prevalence of nonstrabismic accommodative and vergence dysfunctions among primary schoolchildren in Hampyeong, a rural area of South Korea. Of the 589 participants examined, 168 (28.5%) primary schoolchildren presented some form of nonstrabismic accommodative or vergence dysfunctions.The prevalence of Convergence insufficiency **(10.3%)** was more prevalent than others vergence dysfunction. [8]
24. To determine the scientific evidence about the prevalence of accommodative and nonstrabismic binocular anomalies. The search was carried out using MEDLINE, CINAHL, FRANCIS and PsycINFO databases. Prevalence in paediatric and adult populations they identified 660 article. Convergence insufficiency **(2.25 %-33 %).** [33]
25. To determine rate of convergence insufficiency (CI) and accommodative insufficiency (AI) and assess the relation between CI, AI, visual symptoms, and astigmatism in school-age children. In the sample of 484 students. 3rd–8th-grade students completed the Convergence Insufficiency Symptom Survey (CISS) and binocular vision testing with correction if prescribed. rate of symptomatic CI was **6.2%**.[34]

26. This study was performed using a random selection of 593 existing health records of patients between the ages of 5 and 20 years. This study indicate that the most common non-strabismic. convergence insufficiency (**12.6%**).[37]
27. A cross-sectional study was conducted with a randomized sample of 175 university students aged between 18 and 35 years. Prevalence of convergence insufficiency **3.43 %** and convergence excess and accommodation excess, both with a prevalence of 2.29 %. [38]
28. The prevalence of refractive error, binocular vision, and other visual conditions in Australian Indigenous children. The aim of this study was to develop a visual profile of Queensland Indigenous children. 595 primary schoolchildren in Queensland, Australia. CI was twice as prevalent (Indigenous **10%**; non-Indigenous **5%**). [38]
29. The prevalence of general binocular dysfunction with asthenopia was determined for non-presbyopes at an urban optometry clinic serving municipal workers and their dependents. Of the sample of 119 patients, 42.9% had jobs with heavy desk work demands and 39.5% were students. The prevalence of convergence insufficiency in **4.2%.** [40]
30. In a multicenter clinical trial, 310 children 9 to 14 years old with symptomatic convergence insufficiency were randomized. The prevalence of CI **2.6 to 4.7.** [58]

V. Observation work done

In a clinical observation,Total 112 young adult (20-35) patients were screened out of them 30 Males and 82 Females.While screening patients were asked few questions to identify the patients of CI.To diagnose the convergence Near Point of Convergence (NPC) and Positive Fusional Vergence (PFV) were two tests performed.CI may be diagnosed in the presence of asthenopia associated with convergence, but in the absence of a receded near point of convergence,exophoria at near,or reduced positive relative convergence.[2]

Table 1 Clinical Observation

Symptoms	Total no. of patient	Mild (no. of patient)	Moderate(no. of patient)	Severe(no. of patient)
Headache	55	7	31	17
Asthenopia	73	12	37	24
Diplopia	40	6	23	11
Difficulty in reading/near work	54	12	30	12
Trouble in concentration	47	7	27	13
No. patient with no. symptoms of CI	30	Total No. patient identified as CI		82
	Total No. patient observed		112	

Few patient were having symtoms of CI but during performing the test (NPC and PFV) they were in normal range.

VI. Discussion

There is great variability in the reported prevalence of CI ranging from **1.75 to 33%.**With the average prevalence reported to be approximately **5%.**Duane and White and Brown reported a prevalence of **7.5%** CI. Kratka and Kratka reported that **25%** of patients seen in a general ophthalmologic practice had at least 1 finding of CI, and **50%** of those who had 1 sign had all 3 signs with further testing. They reported that **75%** of their CIs were symptomatic and were diagnosed between the ages of 20 and 40 years.

The estimates ranged from **2.25% to 8.3%.** However, the definition of CI was not uniform among the studies. Whether the prevalence of CI varies among ethnic/racial groups is unknown.

Many older studies imply that CI is not common in children, because symptoms are not commonly reported until the second or third decade of life. It had been assumed that young adults spend more time performing near point work than children, thus, young adults are more likely to complain of symptoms.

The CITT Study Group have found a higher prevalence of CI in children than had been previously assumed Fifth and sixth graders were screened to determine both the presence and severity of CI. These children were classified according to the presence and number of the following clinical signs: exophoria at near, insufficient fusional convergence, and receded near point of convergence.

The symptoms associated with accommodative– vergence anomalies are unique and may be differentiated from dry eye and other conditions. The intensity of symptoms in CI may be dependent on the amount and type of near work, degree of suppression, or sensitivity to pain. It affects **3 – 5%** of the population. This is the most common cause of ocular discomfort and muscular asthenopia and common age group is 15 to 25 yrs.In few studies we got **7.7 %** of university students are effected in CI.

From this review study we can come to a conclusion that the prevalence rate of CI is rising day by day, till now the prevalence rate varied from **1%to 33%** worldwide. The studies conducted in India give us a brief idea about the prevalence of CI range from **3%-75%** of the population. Many study also reported that females are more effected than males. [7] , [17] , [21] , [30] , [35].

As in this pandemic situation we are more exposed to the near work,so as the near work increases near problem faced with all age group increases.So CI rate increases as longer time exposure to near work.

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IX. Abbreviations

i. CI: Convergence Insufficiency
ii. NPC: Near Point of Convergence
iii. PFV: Positive Fusional Vergence
iv. SR: Superior Rectus
v. MR: Medial Rectus
vi. LR: Lateral Rectus
vii. IR: Inferior Rectus
viii. SO: Superior Rectus
ix. IO: Inferior Rectus
x. CN: Cranial Rectus
xi. Pd: Prism Diopter
xii. NRA: Negative Relative Accommodation
xiii. MEM: Monocular Estimation Method
xiv. RAF: Royal Air Ruler
xv. SC: Without correction
F: Far
N: Near
xvi. FR: Fixing right
xvii. FL: Fixing left
xviii. BD: Base down prisms
xix. BU: Base up prisms
xx. BO: Base out prisms
xxi. BI: Base in prisms
xxii. ESO: Esotropia
xxiii. L/R: Left hypertropia or right hypotropia
xxiv. R/L: Right hypertropia or left hypotropia
xxv. IPD: Inter Pupillary Distance
xxvi. ΔN= Near deviation
xxvii. ΔD= Distance deviation
xxviii. d=The fixation distance at near in Diopter
xxix. ΔL = deviation with lens
xxx. Δ0 = original deviation
xxxi. D = power of the lens
xxxii. BAND = Binocular Vision Anomalies and Normative Data
xxxiii. RE =Refractive Error
xxxiv. PCI = Pseudo Convergence Insufficiency
xxxv. CVS =Computer Vision Syndrome

X. Appendex

Worksheet

1. Name: Date:
2. Sex:
3. Age:

4. How long you do near work(reading, writing,etc)?
   Ans:

5. How long you use digital devices(mobile, computer,etc)?
   Ans:
   - Mobile:
   - Computer:
   - Others:

6. Do you have any systematic history like DM / HT ?
   Ans:

7. Do you have any history of brain injury/head injury?
   Ans: Yes/No
   - If yes then how long ago?
     Ans:

8. How long he/she is wearing spectacle?

9. Do you smoke cigarettes / drink alcohol ?

10. Have you had any eye operations like lens surgery / Lasik surgery / cosmetic surgery before?

11. If there is a pregnant women then Does she take birth pills ?
    a. Yes / No

12. NPC(near point of convergence):
    Break:
    Recovery:

13. PFV(positive fusional vergence):
    Break:
    Recovery:

XI. Clinical Question Related To CI (Convergence Insufficiency Symtom Survey Questionnaire) [8]

Clinician instructions: Read the following subject instructions and then each item exactly as written. If subject responds with "yes" - please qualify with frequency choices. **Do not give examples.**
Subject instructions: Please answer the following questions about how your eyes feel when reading or doing close work. First think about whether or not you have the symptom. If you do, please tell me whether the problem occurs: Infrequently (not very often), Sometimes, Fairly Often, or Always.

		Never	Infrequently	Sometimes	Fairly often	Always
1.	Do your eyes feel tired when reading or doing close work?					
2.	Do your eyes feel uncomfortable when reading or doing close work?					
3.	Do you have headaches when reading or doing close work?					
4.	Do you feel sleepy when reading or doing close work?					
5.	Do you lose concentration when reading or doing close work?					
6.	Do you have trouble remembering what you have read?					
7.	Do you have double vision when reading or doing close work?					
8.	Do you see the words move, jump, swim or appear to float on the page when reading or doing close work?					
9.	Do you feel like you read slowly?					
10.	Do your eyes ever hurt when reading or doing close work?					
11.	Do your eyes ever feel sore when reading or doing close work?					
12.	Do you feel a "pulling" feeling around your eyes when reading or doing close work?					
13.	Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
14.	Do you lose your place while reading or doing close work?					
15.	Do you have to re-read the same line of words when reading?					
To obtain score, total the number of "X"s in each column						
Multiply by the column value		x0	x1	x2	x3	x4
Sum 5 values						

SCORE: _____