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To Study the Prevalence of Convergence Insufficiency: A Hospital Based Study

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Introduction

Convergence insufficiency (CI) is a binocular vision disorder characterized by difficulty in maintaining fusion while looking at a near target due to a tendency of the eyes to drift outwards. Exophoria that is greater at near than at distance, a remote near point of convergence(NPC), or decreased insufficiency is a common non-strabismic binocular vision disorder and is associated with symptoms such as headache, watering from eyes, visual fatigue and blurring of vision especially on near work. Earlier convergence insufficiency was defined as receding near point of convergence (NPC). Convergence insufficiency may be said to exist when the near point of convergence : more than 11 cm from the inter-ocular base line or 9.5 cm from the apex of cornea or when there is difficulty in attaining 30° convergence.(Duke-Elder 1973). convergence insufficiency (**Scheiman, Wick 2002**) is a condition in which there is -

- ➢ Exophoria at near;
- ➢ Orthophoria or low exophoria at distance;
- ➢ Receded near point of convergence;
- ➢ Reduced positive fusional vergence (PFV);
- ➢ Low AC/A ratio.

Most of the authors have defined convergence insufficiency by a single clinical characteristic, most often the NPC (near point of convergence). Convergence insufficiency was diagnosed when the NPC break exceeded 9 cm. Convergence insufficiency was diagnosed when the NPC, measured with a penlight, was greater than 10 cms. In recent years Scheiman et al (1996) using the criteria of CI as exophoria at near, orthophoria or low exophoria at distance, a receded NPC, a reduced PFV and low AC/A ratio found a prevalence of 5.3% in a population of 1650 children aged 6 to 18 years. An insufficiency of convergence is generally said to exist when the near point, the point of intersection of the lines of sight when eyes are in position of maximum convergence is greater than 10 cm (Von Noorden, Burian (1974). As eyestrain is a common symptom in our clinic population and convergence insufficiency is a common cause of eyestrain, we decided to evaluate the prevalence of convergence insufficiency and its related characteristics using criteria suggested by Scheiman, Wick (2002). Scheiman, Wick (2002) felt that the clinician should try to establish whether there is an increase in severity of

symptoms toward the end of the day, when the patient is tired, or with prolonged use of the eyes. When such a pattern cannot be established, other etiologies should be considered including non-functional causes and malingering.

Material and Methods

200 consecutive patients attending outpatient department of ophthalmology, ASCOMS and hospital Jammu with symptoms of eyestrain were included in the study. Patients with gross uncorrected refractive errors, manifest squint or amblyopia were excluded from the study. A detailed history regarding symptoms of eye strain i.e., headache, blurring of vision, double vision, loss of concentration while studying etc., was taken from the patient. A detailed ocular examination including slit lamp examination and fundus examination was done in all patients to rule out any ocular pathology. All the patients were subjected to the following specific tests:

1 Visual acuity was recorded using Snellen's test types both for distance and near. Each eye was tested separately with or without correcting glasses.

2 Refraction was done using streak retinoscopy to rule out any gross refractive error.

3 Cover-Uncover Test: The presence of heterophoria was detected by noticing that one eye deviated when it was covered, and that it made a movement to regain binocular fixation when cover was removed. Patients with both eyes open were asked to fix a target (point of light / tip of pen / pencil 33 cms away) and each eye was covered and uncovered alternatively. As a cover, we used the back of hand or an occluder or paddle. Covering one eye of patient with normal binocular vision interrupts fusion. Test was again repeated at distance fixation with patients fixing a target 6 m away. Cover test was recorded as follows:

No movement - Orthophoria
Inward Movement - Exophoria
Outward Movement - Esophoria
Upward / Downward movement - Hyperphoria

4. Maddox Rod Prism Test (MRT) was done for subjectively measuring the amount of heterophoria at distance fixation (6 m). Directions. For horizontal deviations, a red Maddox rod with its corrugations horizontal is held in front of the patient's right eye and patient is asked to fix a point of light 6 m away with both eyes. Patient sees a vertical streak of red light with his right eye while the other eye sees a spot of white light. The patient is asked to tell whether the red streak passes through the center, is to the right or to the left of spot of white light. The result is recorded as follows:

a) Streak of red light passing directly through spotlight - Orthophoria
b) Streak to the right - Esophoria
c) Streak to the left - Exophoria

After observing the presence of heterophoria, its amount was determined in prism dioptres by placing prisms base-out for esophoria and base-in for exophoria in front of the right eye, until the red streak traversed the spotlight.

5 Maddox Wing Test: It was done to

a) Detect presence and amount of heterophoria for near fixation (33 cm)
b) Measure AC/A ratio by gradient method

For **AC/A ratio,** patient was instructed to wear his distance glasses (if any) and asked to look directly at center of Maddox wing. Patient was asked to report the number through which the white arrow was passing and whether it was to the right or left of the zero. The procedure was repeated by adding - 1.00 D lenses in addition to the distance prescription. It was assumed that - 1.00 D lenses produced an equivalent of 1D of accommodation and that the accommodative response to the lenses (and therefore the accommodative convergence produced) was linear within a certain range. For a given fixation distance (i.e., 33 cms) the AC/A ratio by the gradient method was inferred by the following formula:

$$AC/A = \Delta 1 - \Delta 0 / D$$

Where $\Delta 0$ is the original deviation, $\Delta 1$ the deviation with the lens, and D the power of the

lens in dioptres. The normal AC/A ratio is between 3 -5. Values above 5 are considered to denote excessive accommodative convergence and values under 3, an insufficiency.

6 Near Point of Convergence (NPC): It was measured by RAF (Royal Air Force) Near Point Rule. The recordings were made in centimeters. The normal NPC was taken as 7 cms.

7 Synaptophore Examination: The following investigations were done on the synaptophore: Simultaneous Macular Perception, Fusion rang & Stereopsis.

Depending on the criteria used by Scheiman, Wick (2002) patients were classified as having convergence insufficiency or no convergence insufficiency.

Observations: Following are the observations of our study:

CI in various Age groups

CI is mainly seen in the age groups of 11-30 years .The maximum number of cases were seen in the age group of 11 -20 years i.e., 38 patients (54.28%).

Table 1 Age Distribution of CI

Age in years	No. of patients	%age
0-10	2	2.85%
11-20	38	54.28%
21-30	20	28.57%
31-40	7	10%
41-50	3	4.2%

Sex Distribution of CI

CI was commoner in females. There were 56 female patients (80.00%) as against 14 male patients (20.00%).

Table 2: Sex Distribution of CI

Sex	No. of Patients	%age
Females	56	80.00%
Males	14	20.00%

Urban / Rural Distribution of CI: CI was found predominantly in the urban population, with 63 patients (90.00 %) from the urban areas of Jammu and only 10 (10.00%) patients from the rural area.

Table 3: Urban /Rural Distribution of CI

Residence	No. of patients	%age
Urban	63	90.00%
Rural	10	10.00%

Distribution of Occupation: The maximum number of patients of CI were students (school / college) i.e.46 (65.71%). No outdoor worker reported to our study with complaints of eyestrain. (Table 4)

Table 4: Distribution of Occupation in CI

Occupation	No. of patients	%age
Student	46	65.71%
Lab Tech	8	11.4%
Stenographer	6	8.5%
Lawyer	5	7%
House Wife	3	4.2%
Ophthal. Asst.	2	2.85%

Symptomatology of CI: Most patients of CI had more than one complaint. The commonest symptom seen was headache on near work i.e., by 42 (60%) patients. The other common symptoms were watering from eyes on near work, burning sensation in eyes on near work and pain in eyes on reading or studying.

Table 5: Symptomatology of CI

Symptoms	No. of patients	%age
Headache	42	60.00%
Burning sensation	12	17.10%
Pain around eyes	10	14.28%
Watering from eyes	16	22.85%
Photophobia	2	2.85%
Pressure sensation around eyes	2	2.85%
Blurring of vision	2	2.85%
Nausea	1	1.42%
Running of words	2	2.85%
Sleepiness when studying	2	2.85%
Itching in eyes	3	4.28%
Intermittent Diplopia	3	4.28%
Floaters	2	2.85%

Distance Phorias on Cover - Uncover Test

Cover - uncover test for distance revealed that out of 70 patients of CI, 63 (90.00%) had exophoria, 7(10.00%) had orthophoria.

Table 6: Distance Phorias on Cover - Uncover Test in CI

Phoria	No. of patients	%age
Exophoria	63	90%
Orthophoria	7	10%

Near Phorias on Cover - Uncover Test: Cover - Uncover test for near using accommodative target on Gulden fixation stick showed that 63 patients (90%) had exophoria, 2patients (2.85%) had orthophoria, and 5(7.5%) patients had an exophoria breaking into exotropia.

Table 7: Near Phorias on Cover - Uncover Test in CI

Phoria	No. of patients	%age
Exophoria	63	90%
Orthophoria	2	2.85%
EXophoria>Exotropia	5	7.1%

Distance Phorias on Maddox Rod Test (in prism dioptres)

On Maddox rod test, 63patients had exophoria, 7 patients had orthophoria. Out of these ,52 had an exophoria of 1-5 prism dioptres while 11 had an exophoria of 6-10 prism dioptres.

Table 8: Distance Phorias on MRT(in prism dioptres, Δ) in CI

Phoria (Δ)	Exophoria	%age	Orthophoria	%age
0-5	52	74.28%	7	10%
6-10	11	15.71%		

Near phorias on Maddox wing test in prism diopters: Exophoria was noted in all 70 patients suffering from CI, out of which 11 patients had exophoria of 1-5 prism dioptres,33had between 6-10 prism dioptres,23 had between 11-15 prism dioptres and 3 had between 16 -20 prism dioptres.

Table 9: Near phorias on MWT(in prism dioptres(Δ)

Phoria (Δ)	Exophoria	%age
0-5	11	15.79%
6-10	33	47.14%
11-15	23	32.85%
16-20	2	4.28%

Synaptophore Examination: Out of 70 patients suffering from CI, 62 patients had simultaneous macular perception while 8 patients had left partial suppression. The PFV (distance) was recorded as adduction in degrees on synaptophore and it was revealed that only 2 patients (2.85%) had adduction between 16-20 degrees.

Table 10: PFV-distance (adduction in degrees) in CI

Adduction (degrees)	No.of patients	%age
0-5	11	15.71%
6-10	21	30%
11-15	26	37.14%
15-20	2	2.85%

The NFV (distance) was recorded as abduction in degrees on synaptophore and it was found that 45 patients (64.28%) had abduction between 4 to 5 degrees while 20 patients (28.57%)between 2 to 3 degrees.

Table 11: NFV-Distance (abduction in degrees)

Abduction (degrees)	No of patients	%age
0-1	3	4.28%
2-3	20	28.57%
4-5	45	64.28%
6-7	2	2.85%

All the70 patients had established stereopsis.

Discussion

Of the 200 patients of eyestrain included in our study, 70 (35%) fulfilled our criteria for the diagnosis of convergence insufficiency. In our study, the maximum number of patients suffering from convergence insufficiency were in the age group of 11 to 30 years i.e., 60 (85 %). **Sen and Malick (1968)** reported maximum cases in the age group of 11 to 20 years i.e., 57%. **Daum (1971)** found that the mean age of patients having CI was 19.9 years. Out of 70 patients, the youngest was 6 years old and the oldest was 47 years old. The prevalence of CI in children less than 10 years was very low i.e., 2 % which is in accordance with the studies of **Kratka (1956), Passmore (1957), Norn (1966), Mazow (1971).**

The sex distribution in our study showed a definite female preponderance with 56 female patients (80%) and only 14 male patients (20%).. **Mahto (1972)** reported female dominance in 70.5% females, males being only 29.4 %. Thus we are in agreement with the majority of authors that CI is commoner in females.

Out of 70 patients, 63 (90%) were from the urban areas of Jammu province while only 7 (10%) were from the rural areas. **Manson (1962)** reported that the percentage of CI in the rural areas was about half of that in urban areas. This could be attributed to a more stressful lifestyle in the cities, easier access to the hospitals and better awareness.

As regards the distribution of occupation, 46 (70 %) of our 70 patients were students - school and college goers. **Mould (1970)** reported that typically most patients with CI are high school or college students and in this subgroup of patients, symptoms are made worse by fatigue or debility so that when the demands are the greatest these patients have the least capacity for near work (as when cramming for an exam or trying to catch up after an illness). Doing homework at the end of the day will be impossible for many of these students. **Mazow (1971)** reported that there are two peaks in the incidence of CI, although the disorder is seen throughout the adult life. An initial peak occurs in the student in high school, college, and graduate school who is required to use his eyes for concentration and prolonged near work. The second peak is reached when an individual approaches the early bifocal age and must learn to use bifocals in order to see clearly at near. He is using his eyes with less accommodative effort at this time, and this results in decreased accommodative convergence. In our study there were 6 stenographers (8.5%), 8 laboratory technicians (11.4%), 2 ophthalmic assistants (3%) and 5 lawyers (7%) - all desk workers. **Duke - Elder (1973)** stressed that symptoms of eyestrain produced by CI depend on patient's occupation. Unless eyes are habitually used for accurate and precise near work, the symptoms may remain unnoticed. Thus desk

workers because of the nature of their work, which demands constant use of eyes for longer periods, experience more eyestrain than others. No outdoor worker reported to our OPD with symptoms and signs suggestive of CI. This is in accordance with **Lyle, Wybar (1979)** who found that the presence of symptoms depends on patient's visual requirement. Thus an outdoor manual worker may experience no symptoms even if his power of convergence is grossly defective whereas a clerical worker with much less weakness of convergence may be seriously incapacitated.

The symptomatology of CI in our study was quite diverse with headache on near work being the most commonly reported symptom i.e., in 60 % patients. The other symptoms seen were burning sensation in eyes (17.5%), pain around eyes (15%), watering from eyes (23%), blurring of words (2.5%), photophobia (2.5 %), nausea (1.5%) pressure sensation around eyes (2.5%). Most patients reported more than one symptom and an association with near work was seen in 96 % of patients. **Daum (1984)** also reported headache as the most frequently occurring symptom (54%), the others being diplopia (47%), blur (47%), asthenopia (36%) in his study of 110 patients of CI.

With regards to the distance phorias in our study of 70 patients of CI, 63 patients (90%) had exophoria while only 7 patients (10%) had orthophoria. The mean distance phoria in our study was 3.6 prism dioptres while the range of distance phorias was from 0 to -8 prism dioptres. . **Von Noorden et al (1973**) reported a mean distance phoria of 2.44 prism dioptres with a range of 0 to -10 prism dioptres in their study of 9 patients of CI. **Daum (1984)** in his study of 110 patients found a mean distance phoria of 3.8 prism dioptres. Most studies have specified a small exophoria at distance.

The mean near phoria in our study was 9.77 prism dioptres while the range of near exophoria was from -2 to -16 prism dioptres.. **Schwyzer (1978)** in his study of 22 patients found mean near

exophoria of 9.55 prism dioptres with a range of -4 to -20 prism dioptres. **Cohen and Sodden (1984)** in their study of 28 patients of CI reported a mean near phoria of 9.52 prism dioptres with a range of -2 to -18 prism dioptres. Most studies have specified a larger exophoria at the near point. Frequently, the criterion at the near point was 5 to 10 prism dioptres exophoria or more. The frequency of near deviation in our study was - 92%(120 patients) with latent exophoria, 5%(6 patients) with intermittent deviation i.e., exophoria breaking into exotropia. **Daum (1984)** reported in his study that most patients had latent deviation of eyes (78%) while intermittent deviation was 20%.

The mean NPC (in cms) in our study was 12.60 cms with a range of 8-22 cms.. **Von Noorden et al (1973)** found a mean NPC of 15.06 cms with a range of 12 - 16 cms in his study. The mean positive fusional vergence (PFV -near) findings in our study of 131 patients with CI were- blur 9.80 prism dioptres, break 11.77 prism dioptres, recovery 9.98 prism dioptres. The mean PFV - distance (i.e, adduction in degrees as measured on the synaptophore) was 7.8 degrees (16 prism dioptres). Nearly all the vergence levels at both near (40 cms) and distance (6 metres) fall below the population standards of the **Optometric Extension Program i.e, OEP (1983)** [PFV-near: blur/ break / recovery in prism dioptres =15/21/15, PFV - distance in prism dioptres =19] and **Morgan's (1944)** table of expecteds (PFV - near :blur/break/recovery in prism dioptres = 17/21/11 and PFV - distance in prism dioptres =19).Our low PFV findings are in accordance with those reported by authors like **Shipman (1983), Kroheletal (1986).**

The mean negative fusional vergence (NFV - near) findings in our study were - blur 10.76 prism dioptres, break 13.38 prism dioptres, recovery 10.36 prism dioptres . The mean NFV - distance was 2.6 degrees (5 prism dioptres). The NFV - distance in our study was at the level of population standards of **OEP (1983)** and **Morgan's (1944)** table of expecteds i.e., 5 prism

dioptres. At the near point, NFV was below the suggested norms of OEP (NFV-near: blur/break/recovery in prism dioptres =14/22/18) and Morgan's table of expected (13/21/13). Three other studies have shown NFV - near values below norms i.e., **Schwyzer (1978), Daum (1984), Cooper et al (1983)**

We found 3 patients (4.2%) with intermittent suppression in our study of 70 patients.. Those with intermittent deviation were much more likely to have some form of suppression as is reported in our study. All our patients had established stereopsis. **Daum (1984)** reported normal stereopsis threshold in his patients of CI.

The prevalence of CI in a sample of 200 patients of eyestrain who reported to our ophthalmological O.P.D over a period of 1 year was 35%. **Pickwell and Stephens (1975)** using criteria of failed standard NPC measurement or jump convergence task reported a CI prevalence of 36% in 200 consecutive optometry clinic patients. **CIRS/ Convergence Insufficiency And Reading Study Group (1997)** found that prevalence of CI can vary tremendously (6% to 50.4%) in a clinical setting depending on which criteria are selected to define this condition. Using the criteria of exophoria at near more than or equal to 4 prism dioptres, insufficient fusional vergence (minimum normative PFV of 12 prism dioptres base - out blur / 15 prism dioptres base - out break and receded NPC of more than or equal to 7.5 cms break, the **CIRS group (1998)** found a 6% frequency of definite CI (exophoria at near and 3 signs) in an optometry clinic population of 620 children. **Porcar and Martinez - Palomera (1999)** did a similar study in a university setting. They defined CI as exophoria at near greater than 6 prism dioptres, low AC/A ratio, reduced PFV at near and a receded NPC. They found a prevalence of 7.7% in a population of 65 university students. In our study, the prevalence of CI was comparatively high probably due to a sampling bias as the patients were preselected complaining of eyestrain.

Conclusion

Out of 200 patients complaining of eyestrain who reported to our ophthalmology OPD, 70 patients (35%) fulfilled our criteria for the diagnosis of convergence insufficiency. Hence the prevalence of convergence insufficiency in our study of 200 patients of eyestrain was 35%. The maximum number of patients suffering from CI were in the age group of 11 to 30 years i.e., 60 patients (85%). The sex distribution in our study showed a definite female dominance with 56 female patients (80%) and only 14 male patients (20%).Out of 70 patients suffering from CI, 63(90%) were from urban areas of Jammu province while only 7(10%) were from the rural areas..In our study, the prevalence of CI was high probably due to sampling bias as the patients were preselected complaining of eyestrain.

Bibliography

1. Borsting E, Rouse MN, De Land, PN, Convergence Insufficiency and Reading Studies"(CIRS) group: prospective of convergence insufficiency and normal binocular children on CIRS symptom survey.Optom Vis Sci 1999;70:221-8.

2. Borsting E, Rouse MN, Scheiman M et al Conveergence Insufficiency and treatment trial group: Validity and Reliability of revised convergence insufficiency symptom survey in children aged 9 to 18 years. Optom Vis Sci 2003;80:832-838.

3. Brinkley JR Jr, Walonker F: convergence amplitude insufficiency. Ann Opthalmol1983;15:826-8,830-1.

4. Duke –Elder S, Wybar K: System of Ophthalmology. 1970;Vol 6 :169-70, 562-70.

5. Granet DG: Quoted in meeting of American Academy of paediatric Ophthalmology,San Diego.2004.

6. Kanski JJ: Clinical Ophthalmology- A Systematic approach, 5th ed. 2003: 520.

7. Porcar E, Martinez - Palomera A: Prevalence of general binocular dysfunction in a population of university students.Optom Vis sci 1997;74:111-3.

8. Scheiman M, Gallaway M et al: prevalence of vision and ocular conditions in a clinical paediatric population. J Am Optom Assoc 1996;67:193-202.

9. Von Noorden GK, Campos EC: Binocular vision and ocular motility-Theory and management of strabismus.2002;6th ed:85-99,502-505.

10. Wick B, Bedell H: Magnitude and velocity of proximal convergence. Invest Ophthalmol Vis Sci 1989;30: 755.