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Original Research Article

Evaluation of Tear Film Dysfunction in Computer Vision Syndrome: A Hospital-Based Cross-Sectional Study

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Abstract

Background: Computer Vision Syndrome (CVS) is increasingly prevalent due to prolonged digital screen use and is commonly associated with ocular discomfort and tear film abnormalities. Tear film dysfunction plays a key role in the development of dry eye symptoms among affected individuals.

Aim: To evaluate tear film dysfunction in patients with Computer Vision Syndrome in a hospital-based cross-sectional study.

Materials and Methods: A total of 150 participants with CVS were included using a convenient sampling technique. Detailed history and symptom assessment were recorded. Tear film evaluation was performed using Tear Break-Up Time (TBUT), Schirmer's test, and ocular surface staining. Data were analyzed using appropriate statistical tests, and p-value <0.05 was considered significant.

Results: Out of 150 participants, the majority were aged 18–45 years. Eye strain (74.7%) and dryness (65.3%) were the most common symptoms. Abnormal TBUT was observed in 62.7% and reduced Schirmer's values in 58.7% of participants. A significant association was found between prolonged screen time and tear film instability ($p = 0.004$).

Conclusion: Early diagnosis and preventive strategies are essential to reduce ocular morbidity and improve quality of life among digital device users.

Keywords: Computer Vision Syndrome, Tear Film Dysfunction, Dry Eye Disease, TBUT, Schirmer's Test, Digital Eye Strain.

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Introduction

Computer Vision Syndrome (CVS), also referred to as digital eye strain, is an increasingly recognized public health concern associated with prolonged use of digital devices such as computers, tablets, and smartphones.

It encompasses a spectrum of ocular and extraocular symptoms including eye strain, dryness, irritation, blurred vision, and headache, significantly affecting quality of life and work productivity. [1] With the rapid digitalization of work environments and increased screen exposure, especially in hospital and office settings, the burden of CVS has risen substantially in recent years. [2]

A key component in the pathophysiology of CVS is tear film dysfunction, which plays a crucial role in maintaining ocular surface integrity and visual clarity. The tear film is a complex, multi-layered structure comprising lipid, aqueous, and mucin components that ensure lubrication, protection, and optical smoothness of the cornea. Disruption in tear film stability, either due to decreased tear production or increased evaporation, can lead to symptoms of dry eye disease (DED), which is frequently observed in individuals with prolonged screen exposure. [3]

Digital screen use has been shown to significantly reduce blink rate and increase incomplete blinking, resulting in increased tear evaporation and ocular surface desiccation. Studies have demonstrated that individuals using computers for more than 4–6 hours daily are at a higher risk of developing tear film instability and dry eye symptoms. [4] Additionally, environmental factors such as air conditioning, poor lighting, and improper workstation ergonomics further exacerbate tear film abnormalities in these individuals. [5]

Objective assessment of tear film dysfunction in CVS includes tests such as Tear Break-Up Time (TBUT), Schirmer's test, and ocular surface staining, which provide valuable insights into tear film stability and quantity. [6] This study aims to evaluate tear film dysfunction in patients with Computer Vision Syndrome in a hospital-based cross-sectional setting.

Materials and Methods

Study Design and Setting: This hospital-based cross-sectional study was conducted in the Department of Ophthalmology of a tertiary care teaching hospital over a period of 6 months from July to December 2025.

The study aimed to evaluate tear film dysfunction among patients diagnosed with Computer Vision Syndrome (CVS).The study population included patients attending the ophthalmology outpatient department (OPD) with symptoms suggestive of CVS. Participants were recruited consecutively during the study period based on predefined inclusion and exclusion criteria. A total of 150 participants were included in the study based on convenient sampling technique method.

Inclusion & Exclusion Criteria: Individuals aged 18–60 years with history of digital screen use ≥4 hours per day along with presence of symptoms suggestive of Computer Vision Syndrome (e.g., eye strain, dryness, burning, blurred vision, headache) were included in the study. However individuals with pre-existing ocular surface disorders (e.g., diagnosed dry eye disease, allergic conjunctivitis) or with history of ocular surgery or trauma within the past 6 months, use of topical ocular medications (except artificial tears), contact lens users or patients with systemic diseases affecting tear production (e.g., Sjögren's syndrome, uncontrolled diabetes mellitus) were excluded from the study.

Data Collection Procedure: After obtaining informed written consent, detailed history was recorded including demographic profile, duration of screen exposure, type of digital device used, working environment, and ocular symptoms. A standardized Computer Vision Syndrome Questionnaire was used to assess symptom severity.

Ophthalmic Examination: All participants underwent a comprehensive ocular examination including:

- Visual acuity assessment using Snellen's chart
- Slit-lamp biomicroscopy for anterior segment evaluation
- Fundus examination where indicated

Assessment of Tear Film Function

Tear film dysfunction was evaluated using the following objective tests:

- **Tear Break-Up Time (TBUT):** Fluorescein dye was instilled, and the interval between a complete blink and the appearance of the first dry spot was measured. TBUT <10 seconds was considered abnormal.
- **Schirmer's Test (without anesthesia):** Standard Schirmer strips were placed in the lower fornix, and wetting was measured after 5 minutes. Values <10 mm were considered indicative of reduced tear production.
- **Ocular Surface Staining:** Fluorescein staining was used to assess corneal epithelial damage and graded using a standardized scoring system.

Outcome Measures: The primary outcome was the prevalence and severity of tear film dysfunction among CVS patients. Secondary outcomes included the association between duration of screen exposure and tear film parameters.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using statistical software SPSS version 21. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

The association between variables was assessed using the Chi-square test or Student's t-test as appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 150 participants with Computer Vision Syndrome (CVS) were included in the study using a convenient sampling technique.

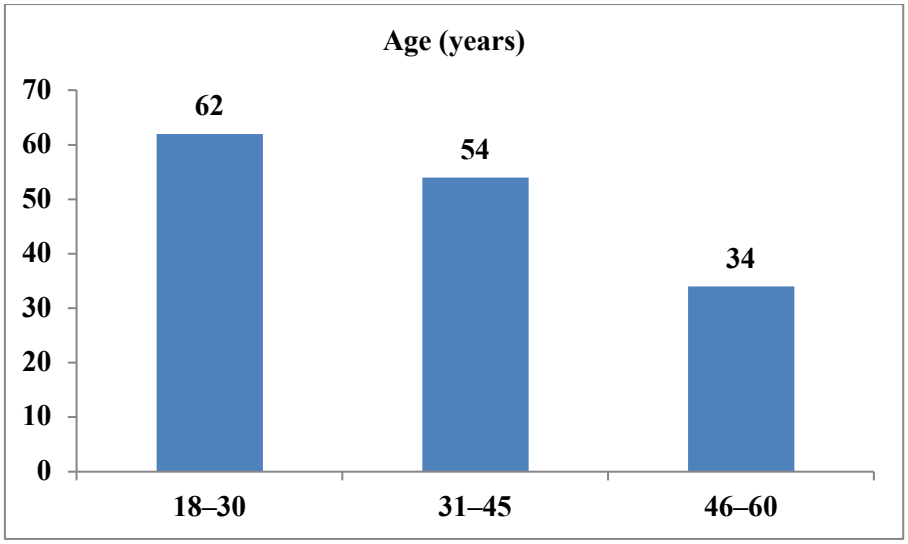

Figure 1: Age Distribution of Participants (n = 150)

The majority of participants belonged to the younger and middle-aged group.

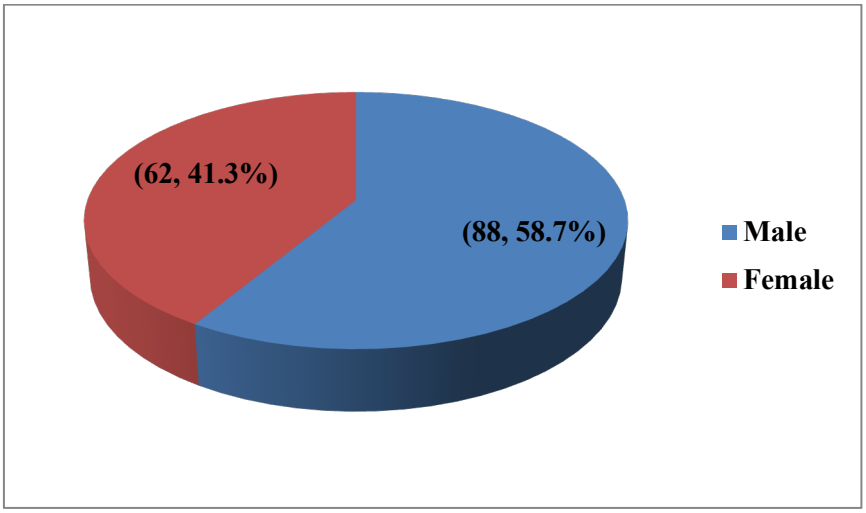

Figure 2: Gender Distribution of Participants (n = 150)

Majority of the study subjects were males.

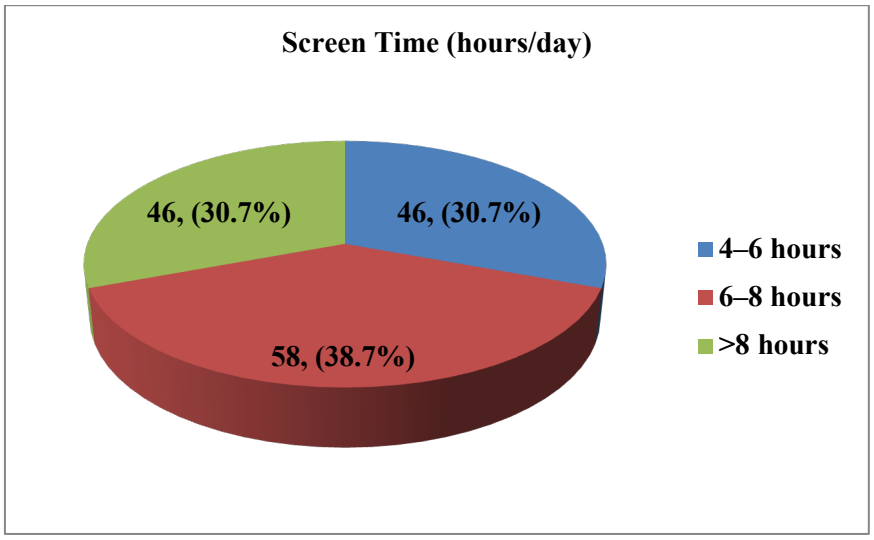

Figure 3: Distribution of Screen Time

Most participants reported prolonged daily screen exposure.

Table 1: Symptom Distribution (n = 150)

Symptom	Frequency (n)	Percentage (%)
Eye strain	112	74.7
Dryness	98	65.3
Burning sensation	86	57.3
Blurred vision	79	52.7
Headache	72	48.0

The most common symptoms were eye strain and dryness.

Table 2: Tear Break-Up Time (TBUT) Values

TBUT (seconds)	Frequency (n)	Percentage (%)
<10 (Abnormal)	94	62.7
≥10 (Normal)	56	37.3

Table 3: Schirmer's Test Results

Schirmer's Value (mm)	Frequency (n)	Percentage (%)
<10 (Reduced)	88	58.7
≥10 (Normal)	62	41.3

Table 4: Corneal Staining

Staining Grade	Frequency (n)	Percentage (%)
Absent	52	34.7
Mild	61	40.7
Moderate	27	18.0
Severe	10	6.6

Table 5: Association of Screen Time and Tear Film Dysfunction

Screen Time	Abnormal TBUT	Normal TBUT	Total
4–6 hrs	20	26	46
6–8 hrs	38	20	58
>8 hrs	36	10	46

Chi-square value = 10.84, p-value = 0.004 (statistically significant)

- A significant association was observed between increased screen time and abnormal TBUT.

Overall Prevalence of Tear Film Dysfunction: Out of 150 participants:

- 94 (62.7%) had abnormal TBUT
- 88 (58.7%) had reduced tear production

This indicates a high prevalence of tear film dysfunction among CVS patients.

Discussion

The majority of participants were in the younger age group (18–45 years), reflecting the increased use of digital devices among the working and student population. Similar demographic patterns have been reported in recent studies as quoted by Sheppard AL et al in 2018 [1] where CVS was predominantly observed in younger individuals due to occupational and lifestyle-related screen exposure. In this study, the most common symptoms were eye strain (74.7%) and dryness (65.3%), followed by burning sensation and blurred vision. These findings are consistent with recent literature, which identifies asthenopia and dryness as the hallmark symptoms of CVS. A study by Ranasinghe et al. [7] reported that more than two-thirds of computer users experience similar symptoms, highlighting the widespread nature of the condition. The high frequency of these symptoms in the present study may be attributed to prolonged screen exposure and reduced blinking during digital device use.

A key finding of this study was the high prevalence of tear film instability, with 62.7% of participants demonstrating abnormal Tear Break-Up Time (TBUT). This aligns with recent evidence suggesting that tear film instability is a primary mechanism underlying CVS. Prolonged screen use has been shown to reduce blink rate by up to 60%, leading to increased tear evaporation and disruption of the tear film as quoted by Uchino M et al. [4] Willcox et al. [8] emphasized that digital screen exposure is strongly associated with evaporative dry eye, primarily due to incomplete blinking and increased ocular surface exposure.

Reduced tear secretion, as indicated by Schirmer's test (<10 mm in 58.7% of participants), was also observed in this study. Although some studies suggest that evaporative dry eye predominates in CVS, the coexistence of reduced tear production indicates a mixed pattern of dry eye disease. Similar findings have been reported in recent observational study done by Subri S et al in 2024

[9], where both aqueous deficiency and tear film instability contributed to ocular discomfort among screen users. This highlights the multifactorial nature of tear film dysfunction in CVS.

The present study also demonstrated a statistically significant association between prolonged screen time and abnormal TBUT ($p = 0.004$). Participants with screen exposure exceeding 6–8 hours per day had a higher prevalence of tear film instability. This finding is in agreement with recent studies, which have consistently shown that increased duration of digital device use is a major risk factor for dry eye disease and CVS. [10] Environmental factors such as air-conditioned workplaces and improper ergonomics may further exacerbate these effects.

Ocular surface staining findings in this study indicated that a considerable proportion of participants had mild to moderate epithelial damage. This is comparable to recent research showing that chronic tear film instability can lead to ocular surface inflammation and epithelial compromise. [4] Such changes, if left unaddressed, may progress to more severe forms of dry eye disease.

Recommendations

1. **Routine Screening for CVS and Dry Eye:** Individuals with prolonged digital screen exposure should undergo periodic ophthalmic evaluation, including tear film assessment (TBUT and Schirmer's test), for early detection of tear film dysfunction.
2. **Adoption of Preventive Strategies:** The **20-20-20 rule** (looking at an object 20 feet away for 20 seconds every 20 minutes) should be encouraged to reduce digital eye strain and improve blinking patterns.
3. **Workplace Ergonomic Modifications:** Proper screen positioning, adequate lighting, anti-glare screens, and maintaining appropriate viewing distance should be implemented to minimize ocular stress.

Limitations

1. **Study Design & Small Smaple Size:** The Cross-Sectional study design limits the ability to establish a causal relationship between screen exposures and tear film dysfunction and sample size of 150 may still be insufficient to represent wider population variability.
2. **Subjective Symptom Assessment:** Symptoms of CVS were partly based on self-reported data, which may be influenced by recall bias or individual perception.
3. **Confounding Factors:** Factors such as environmental conditions (humidity, air conditioning), systemic illnesses, and medication use were not fully controlled, which could have influenced tear film parameters.

Conclusion

The present study demonstrates a high prevalence of tear film dysfunction among patients with Computer Vision Syndrome, with significant association between prolonged screen exposure and tear film instability. Symptoms such as eye strain and dryness were common and correlated with abnormal TBUT and Schirmer's test values.

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