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Original Article

The Effect of Mask Use on the Ocular Surface During the COVID-19 Pandemic

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Abstract

Objectives: The new coronavirus disease 2019 (COVID-19) pandemic emerged in Wuhan, China in October 2019 and spread rapidly all over the world, making extended mask use an inescapable rule of daily life. Literature data indicate that the use of face masks increases the symptoms of dry eye in addition to preventing the spread of COVID-19. The aim of our study was to evaluate the relationship between the clinical signs and symptoms of dry eye and the duration of mask use in healthy individuals using regular face masks.

Materials and Methods: Thirty-five patients aged 20-60 years with no additional ophthalmologic pathology were included in the study. Participants were stratified by duration of face mask use: ≤6 hours/day (group 1) and >6 hours/day (group 2). The patients were assessed with the Ocular Surface Disease Index (OSDI) questionnaire, fluorescein ocular surface staining, and tear break-up time (TBUT) to evaluate the effect of extended mask use on the ocular surface.

Results: A total of 62 eyes of 35 patients, 20 women (57.1%) and 15 men (42.9%), were included in the study. The two mask use duration groups had similar OSDI values (p=0.736). When the ocular surface staining pattern was examined according to the Oxford scale, 50% (10/20) of the eyes in group 1 were assessed as stage 1 and the other 10 eyes as stage 0. In group 2, 47.6% (20/42) of the eyes were assessed as grade 1, 11.9% (5/42) as grade 2, and 4.7% (2/42) as grade 3.

Conclusion: Prolonged face mask use was shown to cause decreased TBUT and increased ocular surface staining even in healthy individuals. Further studies are needed to investigate changes in the tear film after extended daily mask use.

Keywords: COVID-19, mask use, ocular surface, dry eye

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Introduction

Novel coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[1,2] COVID-19 has affected and continues to affect millions of people. Although various vaccines have been studied and applied to prevent the spread of COVID-19 infection, their long-term effects and protectiveness have not been ascertained. Despite ongoing vaccination in various parts of the world, the disease has not been eradicated due to continued transmission and the fact that the vaccination rate has not yet reached 100%.[3] Social distancing, hygiene rules, and the use of personal protective equipment (face masks, visors) are still the most effective ways to prevent the spread of COVID-19 infection.[1,2]

COVID-19 infection is usually spread by close contact or droplet transmission.[4] Although the benefit of using face masks is still a matter of debate, regulatory recommendations led to a rapid increase in their use, especially in enclosed environments where sufficient physical distance cannot be maintained.[1]

In the Tear Film and Ocular Surface Workshop II (TFOS DEWS II) study, dry eye was defined as a multifactorial ocular surface disease characterized by loss of tear homeostasis and subsequent tear instability, hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities.[5] Dry eye disease can be associated with many different clinical symptoms such as ocular pain, dryness, burning, stinging, and foreign body sensation. The Ocular Surface Disease Index (OSDI) was adapted to Turkish by Irkeç et al.[6] and enables the evaluation of subjective symptoms.

The purpose of a face mask is to prevent air from the mouth and nose to spread. However, gaps between the mask and face cause the exhaled air to move upward, creating airflow over the corneal surface.[7] This current accelerates evaporation of the corneal tear film, causing dry spots on the ocular surface. This chain of events results in ocular surface damage and mask-related dry eye disease.[8] The resulting clinical picture demonstrates that prolonged mask use is one of the factors in ophthalmologists' more frequent encounters with ocular symptoms during the pandemic, and has given rise to a new term: mask-associated dry eye.[8,9,10]

Mask-associated dry eye is the most prominent ocular condition associated with masks and may exacerbate existing symptoms in patients who have previously been diagnosed with dry eye, use contact lenses, have low corneal tear quality, have postmenopausal dry eye symptoms, or have undergone eye surgery such as refractive surgery.[9]

To date, studies in the literature examining this subject in different populations have shown that dry eye symptoms may be associated with mask use.[7,8,9,10,11,12] These studies have shown that the feeling of ocular irritation increases with regular mask use.[13] D. E. White, an American ophthalmologist, first described the concept of mask-associated dry eye (which he abbreviated as MADE) on his blog in June 2020.[14] Since then, research has increased in this direction. However, prevalence studies and research into ocular surface staining and quality of life indices are limited and insufficient.[11]

In this study, we aimed to evaluate the relationship between the clinical signs and symptoms of dry eye disease and the duration of mask use in healthy individuals using regular face masks.

Materials and Methods

Ethical approval was obtained from the Hacettepe University Faculty of Medicine Scientific Research Ethics Committee (GO: 20/1023) and the study was conducted in accordance with the ethical principles and practices stated in the Declaration of Helsinki. The study included 35 healthy individuals who presented to the ophthalmology department of Hacettepe University between February 2021 and April 2021 and underwent routine ophthalmologic examination. Patients with signs of retinal pathology, glaucoma, and uveitis were excluded from the study. Each participant's demographic characteristics (e.g., gender, age), comorbidities, contact lens use, ocular surface staining characteristics, fluorescein break-up time, and Schirmer 1 test results were recorded. All participants in the study wore surgical face masks in the standard manner. Those who practiced any additional interventions (e.g., taping on the nose, use of double masks) were excluded from the study. The participants' daily durations of mask use and screen exposure were recorded.

The participants were divided into two groups based on the duration of mask use: ≤6 hours/day (group 1) or >6 hours/day (group 2) at least 5 days per week for the last year. Group 2 included people who wore their mask continuously for the >6-hour period, removing them only during meal breaks. Individuals whose screen exposure time did not exceed an average of 5 hours/day were included in the study.[15] All patients underwent a detailed dilated ophthalmological examination. The patients' Schirmer 1 test, tear break-up time (TBUT), and ocular surface staining patterns were examined. Ocular surface staining was graded from 0 to 5 on the Oxford scale. In addition, symptoms were assessed by administering the OSDI questionnaire. The OSDI survey results ranged from 0 to 100 and were categorized as normal (0-12), mild (13-22), moderate (23-32), and severe (33-100) dry eye.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 23 (IBM Corp, Armonk, NY, USA) software. The Shapiro-Wilk goodness of fit test was used to test whether distributions of numerical variables conformed to normal distribution. Normally distributed numerical variables were presented using descriptive statistics such as mean and standard deviation, while non-normally distributed numerical variables were given using descriptive statistics such as median and interquartile range (IQR). Both the right and left eyes of the participants were included in the study. Due to the covariance structure between the eyes, generalized estimating equation (GEE) analysis was used to analyze variables affected by mask duration. Level of statistical significance was $p<0.05$.

Results

The study included 35 patients who presented to the ophthalmology department of Hacettepe University for eye examination between February 2021 and April 2021. A total of 62 eyes of the 35 participants were included. GEEs were used to avoid any bias in the results. There were 20 eyes of 10 patients in group 1 (mask use ≤6 hours/day) and 42 eyes of 25 patients in group 2 (mask use >6 hours/day). The median age of the study participants was 43.5 years (IQR: 26-60) in group 1 and 27 years (IQR: 23-29) in group 2. Analysis of the duration of mask use by gender showed that 35% of the women in the study were in group 1 and 65% were in group 2. Similarly, 33.3% of the men in the study were in group 1 and 66.7% were in group 2. The participants' descriptive data and ocular surface findings are summarized in **Table 1**. Both groups had similar OSDI scores ($p=0.618$). The mean Schirmer 1 test result was 12.25±1.82 mm/5 min (range: 8.68-15.82) in group 1 and 19.47±1.46 mm/5 min (range: 16.59-22.35) in group 2. The difference between the two groups was statistically significant ($p=0.002$). TBUT was less than 10 seconds in 50% (10/20) of eyes in group 1 and 65% (27/42) of eyes in group 2. However, there was no statistically significant difference between the two groups in terms of TBUT ($p=0.736$). When the ocular surface staining pattern was examined according to the Oxford scale, 50% (10/20) of the eyes in group 1 were assessed as stage 1 and the other 10 eyes as grade 0. In group 2, 47.6% (20/42) of the eyes were assessed as grade 1, 11.9% (5/42) as grade 2, and 4.7% (2/42) as grade 3 (**Figure 1**).

Discussion

In this study, we observed that at least half of the subjects using regular daily facial masks had TBUT less than 10 seconds and increased ocular surface staining, but these findings were not reflected in the OSDI results. OSDI scores were similar in both groups. The expected decrease in Schirmer test results with longer duration of mask use was also not observed. TBUT did not differ according to the duration of facial mask use. Oxford scoring showed a marked shift toward dry eye disease with prolonged mask use. Because there was no subgroup analysis according to duration of screen exposure, only people with less than 5 hours of daily screen exposure were included in this study. This threshold was used based on a report by Al Tawil et al.[15] that screen exposure of up to 5 hours was less associated with ocular surface findings.

In a study assessing 67 eyes with the OSDI, Scalinci et al.[7] showed that OSDI scores increased significantly in individuals who used a mask for at least 6 hours or more 5 days a week for the previous 2 months. They observed that individuals who used masks for shorter periods of time had a lower OSDI score.

Krolo et al.[9] also demonstrated in a study including 203 participants that OSDI score increased with the duration of mask use in patients who had a previous dry eye diagnosis. However, their study only described the worsening of dry eye using OSDI scoring. Unlike other studies, our study included the OSDI as

Table 1. Demographic and ocular surface characteristics according to daily duration of mask use

	Duration of mask use		
	Group 1, ≤6 hours (n=20)	**Group 2, >6 hours (n=42)**	**p***
Age (years), median (IQR)	43.5 (26-60)	27 (23-29)	0.150
Schirmer (mm/5 min), mean ± SD (range)	12.25±1.82 (5-30)	19.47±1.46 (5-35)	0.002
OSDI, mean ± SD (range)	17.58±2.71 (0-31)	15.74±2.51 (0-38)	0.618
Tear break-up time, n (%)			0.736
≤10 s	10 (50)	27 (65)	
>10 s	10 (50)	17 (35)	
Ocular surface staining, n (%)			-
Grade 0	10 (50)		
Grade 1	10 (50)	20 (47.6)	
Grade 2		5 (11.9)	
Grade 3		2 (4.7)	

n: Number of eyes, IQR: Interquartile range (25th-75th percentiles), SD: Standard deviation, OSDI: Ocular Surface Disease Index. *Obtained using generalized estimating equations

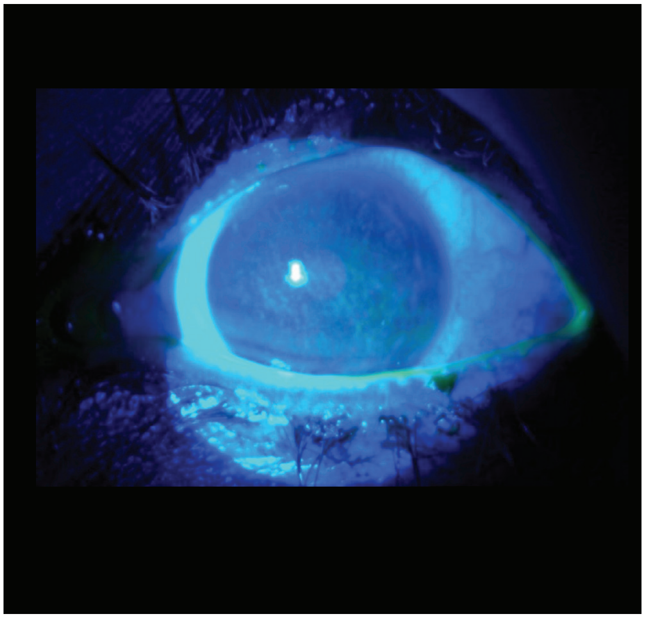

Figure 1. A patient with an OSDI score of 23 showing ocular surface staining
OSDI: Ocular Surface Disease Index

well as the Schirmer test, TBUT, and Oxford scoring, thereby allowing a more objective evaluation. In addition, the inclusion of only individuals with healthy ocular surfaces in the study design increases the reliability of the results.

Moshirfar et al.[8] observed that OSDI scores increased over time with mask use in individuals with no previous dry eye complaints, They also reported that ocular surface complaints increased after uncomplicated cataract surgery.

The most recent TFOS-DEWS II diagnostic pathway is based mainly on clinical symptoms, TBUT, osmolarity, and ocular surface staining.[16] The Schirmer test is not used as a primary assessment. For this reason, Schirmer results, which were also included in our study, should not be considered a direct exclusion criterion for dry eye.

Ocular surface osmolarity has recently been evaluated as one of the main dry eye diagnostic criteria. In mask-associated dry eye disease, it is also possible that mask-mediated intermittent breathing on the ocular surface triggers both irritation and inflammation of the ocular surface.[17] Therefore, the hypothesis that it disrupts osmolarity and consequently leads to ocular and clinical findings has been proposed in other studies, but no quantitative study has been conducted to test this hypothesis.[10] Giannaccare et al.[18] found that OSDI scores were consistent with the idea that abnormal surface evaporation resulting from uncontrolled air flow over the ocular surface may be involved in the pathophysiology of dry eye. Studies should also be conducted on the pathophysiological role of tear osmolarity.

Study Limitations

The main limitations of this study are that it was conducted with a small number of eyes and the duration of the study was short. In addition, the inability to obtain data pertaining to the left eyes of 8 of the patients was another limiting factor. Screen exposure is also known to be an important cause of dry eye and was increased during the pandemic, but people with different screen exposure times were not included in this study. In addition, not analyzing tear osmolarity changes is an important limitation in terms of explaining the etiopathogenesis.

Conclusion

In this study, face mask use was shown to cause decreased TBUT and ocular surface staining even in healthy individuals. Supporting these findings with more comprehensive future studies will help clarify the etiopathogenesis.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the local ethics committee of the Faculty of Medicine (GO: 20/1023).

Peer-review: Externally and internally peer reviewed.

Authorship Contributions

Concept: M.İ., Ö.D., Design: M.İ., Ö.D., Data Collection or Processing: Ö.D., H.T.T., İ.Ö., A.B.Ç., Analysis or Interpretation: Ö.D., S.K., A.B.Ç., Literature Search: H.T.T., İ.Ö., Writing: Ö.D., H.T.T., İ.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

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