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ORIGINAL ARTICLE

# Does facial mask use make our eyes dry? Change in tear meniscus measurements and conventional dry eye tests during facial mask use

**Basak Bostanci, Serdar Ozates, Hasan Basri Arifoglu, Emrullah Tasindi**

**Department of Ophthalmology, Istanbul Okan University Faculty of Medicine, Istanbul, Turkey**

## Abstract

**Purpose:** The objective of the study is to evaluate the effect of mask use on tear meniscus (TM) measurements obtained by anterior segment optical coherence tomography (AS-OCT) and on conventional dry eye tests.

**Methods:** Right eyes of 86 healthy individuals were included in the study. Lower TM parameters were measured with AS-OCT and TM height (TMH) and depth (TMD) were calculated with facial masks on and 1 h after taking the masks off. Schirmer's and tear break up time (TBUT) tests were measured under the same circumstances.

**Results:** Mean age of the individuals was 34.4±9.6 years. Of the 86 individuals, 40 (46.5%) were male and 46 (53.5%) were female. Mean age did not differ between genders (p=0.309). Mean TMH and TMD were significantly lower in individuals with face mask (p<0.001, p<0.001, respectively). TBUT score was significantly lower in individuals with face mask (p<0.001). The mean Schirmer score did not significantly change between measurements (p=0.471). The mean mask on and mask off TMH, TMD, Schirmer's test, and TBUT outcomes did not significantly differ between males and females in the study (p>0.05 for all).

**Conclusion:** Wearing facial masks seem to affect the TM parameters and decrease TBUT of the patients. This may explain the irritation symptoms in the eyes of the patients when using masks. Appropriate measurements should be taken in order to relieve these ocular symptoms, since wearing masks become a daily routine of our lives for protection against airborne pathogens.

**Keywords:** Break up time; facial mask; optical coherence tomography; Schirmer's test; tear meniscus.

Since the report of a pneumonia outbreak in Wuhan, in December 2019, the world has been facing a pandemic, the Coronavirus Disease 2019 (COVID-19), which is caused by the new Coronavirus (novel coronavirus: nCOV-Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).[1,2] After introduction of the disease, World Health Organization (WHO) declared the situation as a public health emergency of international concern and suggested protective measures to prevent transmission.[3,4]

The primary route of transmission of airborne pathogens like SARS-COV-2 is via droplets and aerosols which are ejected when the infected person speaks, coughs or sneez-

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**Correspondence:** Basak Bostanci Ceran, M.D. Department of Ophthalmology, Istanbul Okan University Faculty of Medicine, Istanbul, Turkey
**Phone:** +90 216 677 16 30 **E-mail:** drbbostanci@gmail.com
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es.[5] Because of that, among the protective measures of WHO, use of masks by the general population is accepted as an important tool in combating the disease.[2] Masks are used for protection of the wearer from the infected droplets, as well as for source control, by blocking droplets ejected by the wearer. Although masks like N95 respirators are recommended for healthcare professionals who conduct aerosol-generating procedures, surgical masks have been in use by most of the population.[6]

On the other hand, mask-related ocular irritation symptoms have been observed by ophthalmologists, lately.[7] Redness, itching and burning symptoms are amongst the most common problems reported by patients who use masks daily.[7] Although there have been few reports about the ophthalmic manifestations of the SARS-CoV-2, discussion about the effect of prolonged mask use on the ocular surface is absent. We hypothesize that some of those symptoms might be relevant to regular mask-wearing and its effect on tear film. The present study aims to compare the tear meniscus (TM) height (TMH) and depth (TMD) of the patients and conventional dry eye tests with the facial mask on and off.

## Materials and Methods

This cross-sectional study was conducted at the Okan University Medical Faculty, Istanbul, Turkey between August and September 2020. The study protocol was approved by the institutional board of the Okan University Medical Faculty ethics committee. The study was designed and conducted according to the tenets of the Declaration of Helsinki and; purposes, design, and possible complications were explained to all individuals and written consent forms were obtained.

The right eyes of 86 healthy individuals who wear facial masks for protection against airborne pathogens were included. All individuals were part of the hospital staff and working indoors in the same floor at 21–23°C and 30–40% humidity. Humidity and temperature were controlled by the central heating system of the hospital. Patients with systemic infection or disease that may affect the eye, dry eye syndrome, eyelid problems, conjunctival or corneal disorders, glaucoma, retinal pathologies, contact lens use, history of ocular surgery eye drop use, and any systemic drug use that may affect ocular surface parameters were excluded from the study. Only subjects that had been wearing a surgical mask for 3 h were included in the study. All individuals used a standard disposable surgical face masks with ear loops. All professional hospital staff is educated for the proper use of facial masks, which cover the nose and mouth without any air escape, to avoid inappropriate use of the masks.

All ophthalmic examinations and measurements were obtained by the same experienced clinician who was blinded to the study hypothesis and design. All individuals underwent a complete ophthalmic examination including ocular surface and anterior segment assessment. Corneal and conjunctival staining was assessed in each patient. Patients underwent anterior segment optic coherence tomography (AS-OCT) imaging, tear breakup time (TBUT) tests and Schirmer's test, respectively while they were using face masks. 1 h after taking off the masks, same tests were repeated. Appropriate control measures were taken in order to prevent airborne pathogen transmission during tests. The examiner wore N95 masks, gloves and face shields and the tests were performed in a separate examination room where no other patients were accepted.

The anterior segment mode of the spectral-domain 3D OCT-2000 (Topcon Inc., Japan) system was used for TM measurement. This system has a 6.0 mm vertical beam which captures 50,000 axial scans/s and has a 5 μm axial resolution to a depth of 3 mm. Patients were asked to rest their forehead against the headrest and chins on the chin-rest and look straight ahead to the fixation target. All individuals were asked to blink a couple of times and measurements were obtained after 2 s for standardization. A built-in manual caliper was used to measure TMH and TMD. The TMH was accepted to be the distance between the points where meniscus intersects the cornea and the eyelid. The TMD was measured from the mid-point of the air-meniscus interface to the eyelid inferiorly.

In order to evaluate both basal and reflex tear secretion Schirmer's test was applied without anesthesia. A filter paper strip (35×5 mm) was placed at the junction of middle and lateral third of the right lower lid and the amount of tear production in 5 min was measured in all individuals. All patients were asked to close their eyes during the test. For TBUT test, a fluorescein strip was wet with saline and applied into the lower conjunctival sac. After blinking few times, right eyes were observed. The period from fluorescein installation to the appearance of first dry spot was measured.

Statistical analyses were performed with SPSS Statistics (Version 22.0, Armonk, NY: IBM Corp). Normal distribution of the data was tested by the Kolmogorov-Smirnov test. Descriptive data were analyzed. Differences between the measurements were tested with paired samples t-test and differences in the measurements between the genders

were tested with independent samples t-test. A $p<0.05$ was assumed statistically significant.

## Results

Eighty-six healthy individuals were included in the study. Of the 86 individuals, 40 (46.5%) were male and 46 (53.5%) were female. The mean age of the individuals was 34.4±9.6 years (min: 18, max: 58). Mean age did not differ between genders (p=0.309). Corneal and conjunctival staining were absent in subjects. Table 1 shows the outcomes and comparison of the measurements. Mean TMH and TMD were significantly lower in individuals with face mask. Mean TBUT score was significantly lower in individuals with face mask. The mean Schirmer's score did not significantly change between measurements.

The mean mask on TMH, TMD, Schirmer's test, and TBUT outcomes did not significantly differ between males and females (p=0.147, p=0.167, p=0.448, p=0.898, respectively). The mean mask off TMH, TMD, Schirmer's test, and TBUT outcomes did not significantly differ between males and females (p=0.067, p=0.097, p=0.358, p=0.721, respectively).

## Discussion

Patients have been reporting ocular irritation symptoms and epiphora during prolonged facial mask use lately, which must be investigated and treated.[7] Tear film changes and irritation of the ocular surface are thought to be the reason behind those symptoms, which may vary from classic irritation and impaired vision to tear film instability with damage of the corneal epithelium.[8] In Belmonte et al.'s[9] study, the magnitude of the ocular surface sensation was observed to be increased proportionally to the flow of air and was reported to be higher with warmed air. This may explain the reason why "prolonged" mask use causes irritation symptoms. The continuous warm air escaping from the mask and blowing over the ocular surface may evaporate the tear film and activate the sensory fibers of the ocular surface and thus evoke unpleasant sensations in the eye. Also, air escaping from the mask due to inappropriate use of the facial mask may worsen the ocular irritation symptoms.

Corneal sensory nerve afferents arise from the ophthalmic division of the trigeminal nerve and conjunctival afferents carry additional sensation via the nasociliary, lacrimal, frontal, and infraorbital nerves.[10,11] Primary afferent neurons innervating the ocular surface can be activated by different stimuli such as mechanical impact, temperature, or irritants.[12] The continuous evaporation and dryness of the ocular surface may cause redness and itching sensation in patients during mask use and may cause compliance issues such as the need for mask removal or eye rubbing.

While discussion of the effect of prolonged mask use on ocular surface is absent from the literature; there are some reports about eye related side effects of continuous positive airway pressure (CPAP), which is used for treatment of obstructive sleep apnea. These symptoms were explained by the use of a poorly sealed mask, which would allow air leakage and blow over the ocular surface.[13,14] Similarly, Moshirfar et al.[7] reported that the majority of patients described an awareness of air blowing upward from the face mask into their eyes which may result in ocular surface irritation or inflammation. In addition to that; Giannaccare et al.[16] reported that 10% of the subjects with prolonged mask use described appearance or worsening of ocular discomfort symptoms.

Holding at least three quarters of the total tear volume, the TM represents the tear quantity of a person.[8] TM volume can be measured with various methods such as reflective meniscometry, video assessment, and fundus camera; but all these techniques have been found to be unreliable in assessment of the tear film.[9,10] Previous studies show that measurement of the height and depth of the TM with AS-OCT is valuable for evaluating the tear film volume and has high sensitivity for evaluating dry eye, in addition to conventional diagnostic tests such as the Schirmer test and TBUT.[11,12] We have found a significant decrease in TMH and TMD of the patients while using the mask. Like CPAP, the poorly sealed masks, which would allow air leakage and blow over the ocular surface is thought to be the reason for those findings. Likewise, TBUT scores of the patients were lower when they were using facial masks.

**Table 1.** Mean outcomes and comparison of the measurements

| | Mask on (n=86) | Mask off (n=86) | p-value |
|---|---|---|---|
| Tear meniscus height (μm) | 122.8±43.9 | 196.9±48.2 | <0.001 |
| Tear meniscus depth (μm) | 106.1±48.0 | 164.9±55.6 | <0.001 |
| Schirmer's test (mm) | 18.6±3.4 | 18.1±4.5 | <0.471 |
| Tear breakup time (second) | 9.1±1.1 | 10.8±1.4 | <0.001 |

*Bold text indicates statistical significance.

Since dry eye patients were not included in the study, Schirmer's scores were normal and statistically similar between the groups. The reason for this indifference can be explained by the fact that all patients were asked to close their eyes during the test and as a result, there was no air flow on the ocular surface to evaporate the tear film. When subgroup analysis was made, there was no difference in TM parameters between genders. In Golebiowski et al.'s study, the examiners found the corneal and conjunctival sensitivity higher in female subjects and also reported an age-related increase in corneal sensitivity.[17] The insignificant difference might be associated by the nature of our patient cohort. All female subjects in our group were in the premenopausal period and none of them had dry eye symptoms in the pre-mask period.

The study results confirmed the existence of mask-associated dry eye that was described by several clinical studies.[13,14] Krolo et al.[14] reported that wearing a face mask longer than 3 h/day was associated with dry eye symptoms. Mask-associated dry eye may cause worsening of existing dry eye disease or aggravate the ocular irritation symptoms in patients with cataract or refractive surgey and contact lens wear.[15]

The present study had several limitations. The study population was limited; therefore, the present study results cannot be generalized for real world. In the present study, only a limited time of facial mask wear was evaluated, which may distort our study results. Further studies with larger population and longer facial mask use are required to understand the effect of facial mask use on the ocular surface.

## Conclusion

Wearing facial masks seem to affect the TM parameters and decrease TBUT of the patients. This may explain the irritation symptoms in the eyes of the patients when using masks. The ocular symptoms reported by an increasing number of patients not only have a potential to decrease compliance for mask use but also may increase eye rubbing and face touching behavior, which may increase fomite transmission. Especially for individuals who use masks for extended periods and patients with ocular surface disorders, protective measures should be taken to prevent ocular irritation. Relieving the ocular symptoms during mask use may help increase compliance and bring us closer to the goal of reducing the spread of the infection.

**Ethics Committee Approval:** This study was approved by Okan University Faculty of Medicine Ethics Committee (date: 12.6.2020; number: 2020/104).

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**Conflict of Interest:** None declared.

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