Mask-Associated Dry Eye Disease: A New Global Reality

Olho Seco Associado à Máscara: Uma Nova Realidade Mundial

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ABSTRACT

INTRODUCTION: The COVID-19 pandemic introduced significant changes in our daily habits, including the widespread use of face masks. Numerous reports pointed to an increase in perceived dry eye symptoms, due to an unnatural airflow towards the ocular surface during expiration.

The purpose of this work was to assess the change in dry eye symptoms in healthcare professionals with the frequent use of face masks and to measure the effect of a half-workday period of mask wearing in noninvasive ocular surface parameters.

METHODS: Ocular Surface Disease Index (OSDI) questionnaire was used to assess symptoms of dry eye disease. In each answer, the participants were asked to self-report the symptoms before and after the generalized use of face masks. In addition, all volunteers underwent a noninvasive ocular surface workup by means of TearCheck® (ESW Vision, Linz, Austria) in the same day at 2 different time points: 1 - in the beginning of the work shift before wearing face mask; 2 - after 6 hours of continuous face mask use. Eye redness score (range 1-4), non-invasive break-up time (NIBUT), tear meniscus thickness and tear film stability evaluation (TFSE®) variation between the two measurements was calculated.

RESULTS: Forty eyes from 20 subjects were included. A percentage of 80% (n=16) of the participants were female and the mean age of the sample was 47.15 ± 12.99 years old. A mean increase in the OSDI score of 15.33 ± 10.80 points was noted when comparing the pre- and the COVID-19 periods ($p<0.001$***). Concerning the ocular surface parameters, the following evolution was observed after 6 hours of face mask use: eye redness score increased 0.75 ± 0.74 points ($p<0.001$***); tear meniscus thickness decreased 0.04 ± 0.13 mm ($p=0.034$*); and NIBUT reduced 2.20 ± 3.82 s ($p=0.007$**). A non-significant increase in TFSE® of 45.11 ± 212.26 points was also noticed ($p=0.211$).

CONCLUSION: We report a clear increase in dry eye symptoms and signs associated with the use of face masks. Ophthalmologists should advise their patients of the potential ocular surface health risks related to face masks, and fitting strategies should be adopted to minimize the discomfort associated with this condition.

KEYWORDS: COVID-19; Dry Eye Syndromes; Health Personnel; Respiratory Protective Devices

RESUMO

INTRODUÇÃO: A pandemia COVID-19 introduziu mudanças significativas nos nossos hábitos diários, incluindo o uso frequente de máscaras faciais. Vários relatos apontaram para um aumento dos sintomas de olho seco, causado pelo fluxo anormal de ar em direção à superfície ocular durante a expiração.

O objetivo deste trabalho foi avaliar a mudança nos sintomas de olho seco em profissionais de saúde com o uso frequente de máscaras faciais e medir o efeito da utilização de máscara durante meio período de trabalho na superfície ocular.

MÉTODOS: O questionário *Ocular Surface Disease Index* (OSDI) foi usado para avaliar os sintomas da doença do olho seco, antes e após o uso generalizado de máscaras faciais. Além disso, todos os voluntários foram submetidos a uma avaliação não invasiva da superfície ocular através do equipamento TearCheck® (ESW Vision, Linz, Áustria) no mesmo dia em 2 momentos diferentes: 1 - no início do turno de trabalho antes do uso da máscara facial; 2 - após 6 horas de uso contínuo da máscara facial. Foi calculada a variação dos parâmetros: *score* de vermelhidão ocular, tempo de ruptura não invasivo (NIBUT), espessura do menisco lacrimal e avaliação da estabilidade do filme lacrimal (TFSE®).

RESULTADOS: Foram incluídos 40 olhos de 20 voluntários, 80% (n=16) do sexo feminino e com média de idades de 47,15 ± 12,99 anos. Um aumento médio no OSDI de 15,33 ± 10,80 pontos foi observado ao comparar os períodos pré e COVID-19 (p<0,001***). Em relação aos parâmetros da superfície ocular, observou-se a seguinte evolução: o score de vermelhidão ocular aumentou 0,75 ± 0,74 pontos (p<0,001***); a espessura do menisco lacrimal diminuiu 0,04 ± 0,13 mm (p=0,034*); e o NIBUT reduziu 2,20 ± 3,82 s (p=0,007**). Verificou-se também um aumento não significativo do TFSE® de 45,11 ± 212,26 pontos (p=0,211).

CONCLUSÃO: Relatamos um claro aumento dos sintomas e sinais de olho seco associado ao uso de máscaras faciais. Os oftalmologistas devem alertar os seus pacientes sobre os potenciais riscos para a superfície ocular relacionados com as máscaras faciais e promover a adoção de estratégias de adaptação da máscara para minimizar o desconforto associado a essa condição.

PALAVRAS-CHAVE: COVID-19; Dispositivos de Proteção Respiratória; Pessoal de Saúde; Síndromes do Olho Seco.

INTRODUCTION

Our everyday routines have changed significantly as a result of the COVID-19 pandemic, with new practices such as maintaining physical distance, performing hand hygiene, and wearing protective face masks.[1-15] Numerous reports from all across the world indicated a perceived rise in dry eye symptoms, such as irritation, blurred vision, foreign body sensation, pain, and itching. This was especially true after the widespread usage of face masks.[2,6,8,13] The raised awareness for this possible association sparked research on the subject and a few studies were published in 2021 and 2022, reporting significant changes in Ocular Surface Disease Index (OSDI) score and ocular surface parameters, including tear meniscus height, tear film break up time, corneal fluorescein staining, and Schirmer-I test.[4,7,14] These findings led to the consolidation of a new clinical entity called "mask-associated dry eye" (MADE).[10,11]

Since most of the commonly used face masks are not air-tight superiorly, this design causes an abnormal airflow toward the eyelids and ocular surface during expiration, which could explain the above mentioned findings.[9]

In this sense, the purpose of this work was to assess the change in dry eye symptoms in healthcare professionals with the frequent use of face masks associated with the COVID-19 pandemic and to measure the effect of a half-workday period of mask wearing in noninvasive ocular surface parameters.

MATERIAL AND METHODS

Healthcare workers from our center (Centro Hospitalar Universitário de São João, Porto, Portugal) were recruited. OSDI questionnaire was used to assess symptoms of dry eye disease. In each answer, the participants were asked to self-report the symptoms at two different time points: before the generalized use of face masks (before COVID-19 pandemic) and at present. In addition, all volunteers underwent a noninvasive ocular surface workup by means of TearCheck® (ESW Vision, Linz, Austria) in the same day at 2 different time points: 1 - in the beginning of the work shift before wearing face mask; 2 - after 6 hours of continuous face mask use. Eye redness score, non-invasive break-up time (NIBUT), tear meniscus thickness and tear film stability evaluation (TFSE®) variation between the two measurements was calculated. Eye redness was scored from 1 to 4 according to the example pictures displayed by the device. To provide an unbiased classification, the investigators were blinded to the timing of the evaluation. Regarding tear meniscus evaluation, the device was always able to measure its thickest point and, in some eyes, also the thickness below the iris center. For comparisons purposes, only the first measurement was considered. NIBUT was assessed in a scale of 2 to 10 s, with values out of this range being reported as under or over the detection limit. Values under the range were considered as 1 s and over the limit were classified by the investigators as 11 s. Eyes in which the first measurement of NIBUT was under the lower limit were not considered for evaluation of this parameter. Lastly, TFSE® assesses the frequency and intensity of micro-deformations occurring on the ocular surface over a 10-second period. Higher scores reflect more instability of the tear film.[5] Cases in which errors were detected in the measurement of TFSE®, showcased by the highlighting of dots out of the ocular surface, were excluded from the analysis.

The study was conducted according to the tenets of the Declaration of Helsinki and all volunteers gave their consent for the analysis and publication of the collected data.

Statistical analysis was performed using SPSS software, version 22 (IBM, Chicago, IL). To compare differences between groups, paired samples t test was used. *P*<0.05 was considered significant.

RESULTS

Forty eyes from 20 subjects were included. A percentage of 80% (n=16) of the participants were female and the mean age of the sample was 47.15 ± 12.99 years old.

Regarding the assessment of dry eye disease symptoms, the mean OSDI score reported before the generalized use of face masks and during COVID-19 pandemic was 15.11 ± 10.37 and 30.44 ± 13.63, respectively. In other words, a mean increase in the OSDI score of 15.33 ± 10.80 points was noted when comparing the pre- and the COVID-19 periods (*p*<0.001***).

Concerning the ocular surface parameters, eye redness score was 1.55 ± 0.84 in the beginning of the work shift and 2.30 ± 0.69 on the second evaluation, increasing 0.75 ± 0.74 points (*p*<0.001***) after 6 hours of face mask use. Tear meniscus thickness decreased 0.04 ± 0.13 mm (*p*=0.034*) between the two evaluations, with a mean baseline value of 0.48 ± 0.19 mm and a final mean of 0.44 ± 0.16 mm. In the same fashion, NIBUT was 9.65 ± 2.05 s in the first measurement and 7.46 ± 4.23 s after the 6 hours work shift, reducing 2.20 ± 3.82 s (*p*=0.007**) amongst the assessments. Lastly, a non-significant increase in TFSE® of 45.11 ± 212.26 points was also noticed (*p*=0.211), with a mean value of 116.61 ± 147.21 and 161.72 ± 199.61 in the two evaluations, respectively.

Age and sex did not correlate with any of the variables evaluated.

Table 1 resumes the data regarding the OSDI score and the ocular surface parameters in both evaluations and their variation. Figs. 1, 2, 3 and 4 shows examples of the variation of the ocular redness score, tear meniscus thickness, NIBUT and TFSE®, respectively, between the two assessments.

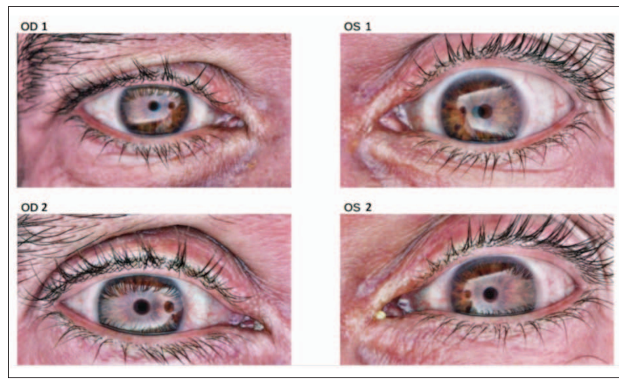

Figure 1. Example of eye redness assessment. Both eyes (OD and OS) were classified as 1 and 3 in the 1st and 2nd evaluations, respectively.

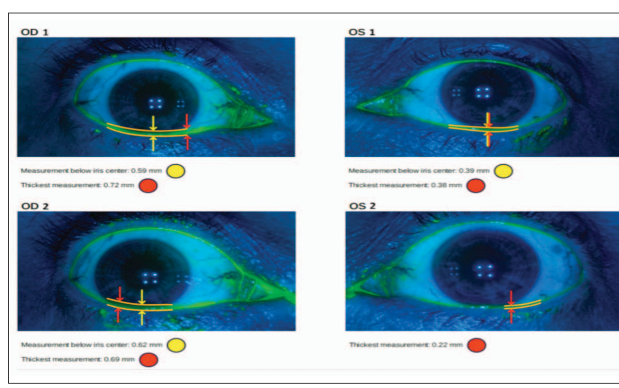

Figure 2. Example of tears meniscus thickness evaluation. As explained in the methods section, the thickest measurement was considered for analysis, since the measurement below iris center was not always available. A variation from 0.72 to 0.69 mm and 0.38 to 0.22 mm can be observed in the right (OD) and left eye (OS), respectively.

Table 1. OSDI and ocular surface parameters evaluation in the beginning of the work shift (1st evaluation) and after 6 hours of continuous face mask use (2nd evaluation) and its variation.

Parameter	1st evaluation	2nd evaluation	Variation	*p* Value
OSDI score	15.11 ± 10.37	30.44 ± 13.63	15.33 ± 10.80	<0.001***
Eye redness	1.55 ± 0.84	2.30 ± 0.69	0.75 ± 0.74	<0.001***
Tear meniscus thickness (mm)	0.48 ± 0.19	0.44 ± 0.16	0.04 ± 0.13	0.034*
NIBUT (s)	9.65 ± 2.05	7.46 ± 4.23	2.20 ± 3.82	0.007**
TFSE®	116.61 ± 147.21	161.72 ± 199.61	45.11 ± 212.26	0.211

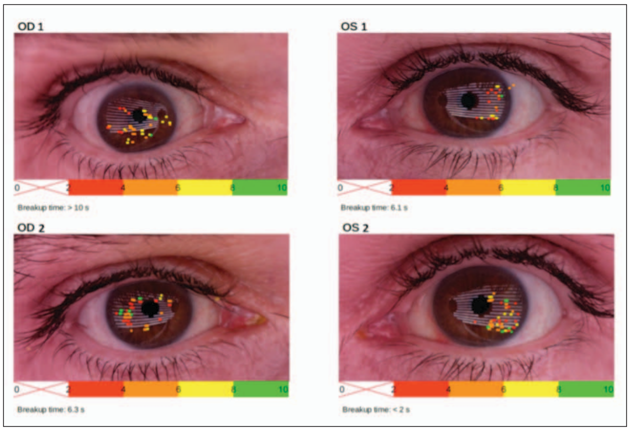

Figure 3. Example of non-invasive break up time (NIBUT) evaluation. As explained in the methods section, the values under 2 s and over 10 s were considered as 1 s and 11 s, respectively. A variation from 11s (>10) to 6.3 s and 6.1 to 1 s (<2) can be observed in the right (OD) and left eye (OS), respectively.

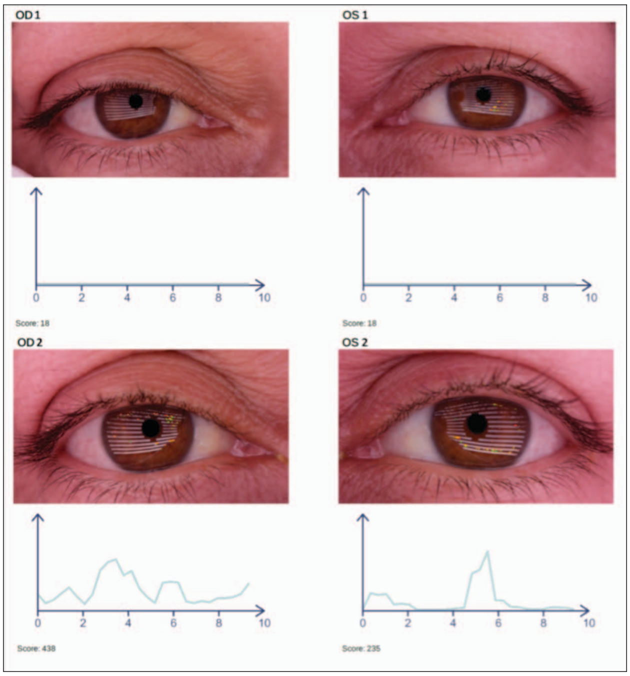

Figure 4. Example of tear film stability evaluation (TFSE®). A score variation from 18 to 438 and 18 to 235 can be observed in the right (OD) and left eye (OS), respectively.

DISCUSSION

This study assessed the variation in dry eye symptoms associated with the COVID-19 pandemic, as well as the diurnal changes in noninvasive parameters of the ocular surface of healthcare professionals following continuous face mask use for 6 hours in the same setting.

Regarding OSDI scores, a mean increase of almost 20 points was observed in our sample, confirming the first reports of this new clinical entity called MADE.[10,11] Online questionnaires were used in two published research to evaluate this association, and both reported an increase in dry eye symptoms related to face mask use.[2,6] Moreover, an Italian group compared the OSDI scores of 67 patients between Fall 2019 and Spring 2020 and described a median increase of 2.09 points.[13] This variation was not as pronounced as the one observed in our sample, which may be explained by differences in the samples studied. However, we might also speculate that using a face mask for longer lengths of time may have a cumulative effect on dry eye symptoms, since the questionnaire was applied at the beginning of the COVID-19 pandemic in the aforementioned study, whereas in our case it was tested after two years of generalized face mask use.

Another study recruited 33 healthcare professionals and collected the OSDI scores before wearing the mask in the morning and after removing the mask at the end of the work-day, reporting a mean increase of more than 7 points in the second evaluation.[4] Since in the OSDI questionnaire, the subject is asked to report symptoms of dry eye disease in the prior week, we considered more accurate to ask the participants to contemplate a pre-pandemic and a pandemic situation when self-reporting their symptoms. Nevertheless, as in the previous study, a significant increase in dry eye symptoms was notorious.

Furthermore, Krolo *et al* reported significantly higher OSDI scores in participants who used face mask for 3-6 hour/day when compared to the <3 hour/day group (15.3 *vs* 8.3). In the same study, volunteers with prior dry eye disease showed significantly greater OSDI scores and also greater worsening of their disturbances during mask wearing period, regardless of daily mask wear duration.[10]

When evaluating non-invasive ocular surface parameters, a 6-hour period of face mask use increased all the measured variables: ocular redness score, tear meniscus thickness, NIBUT and TFSE®.

Giannacare *et al* reported a significant decrease of 0.5 mm tear meniscus height after using face mask for 8 hours. However, NIBUT, redness score and meibomian gland dropout did not significantly changed in the same setting.8 Baris *et al* described a decrease of 1 s in BUT from 8 am to 5 pm in healthcare professionals using face masks.[4]

A study published in 2022 analyzed tear soluble factors before and after the face-mask period and described increased levels of IL-1, IL-33, IFN, NGF, BDNF, LIF and TSLP and decreased concentrations of IL-12, IL-13, HGF and VEGF-A. The levels of MUC5AC and MUC6 were also elevated. *Ex vivo*, human donor and corneoscleral explant cultures under elevated CO_2 stress revealed a similar molecular profile, suggesting hypercapnia is a potential contributor to ocular surface discomfort.[3]

Although we report some interesting findings, our study has several limitations that should be mentioned. Firstly, the limited sample size could have hampered the detection of statistical significance for some parameters and to generalize the results. Second, when applying the OSDI score, we asked the patients to consider a pre-pandemic period, which may have been affected by a recall bias. Thirdly, further invasive procedures could have been carried out to cast more light on the development of this condition, including the measurement of tear osmolarity. However, because every participant was working during the evaluation, we chose to avoid any tests that would have caused ocular discomfort. Fourth, the impact of taping the upper mask edge was not examined. Improvements in ocular surface stability and discomfort symptoms have been linked to this approach.[12] Finally, diurnal variation of tear meniscus volume has been reported in the past, with highest values recorded upon awakening that gradually decreased in the evening. Therefore, more understanding of the daily change of ocular surface parameters could be gained by contrasting our findings with those of a group of subjects who did not wear a face mask.[1]

In conclusion, we report a clear increase in dry eye symptoms and signs associated with the use of face masks. Face masks may pose dangers to the health of the ocular surface; ophthalmologists should inform their patients of these concerns and provide fitting techniques to lessen any symptoms that may result.

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CONTRIBUTORSHIP STATEMENT / DECLARAÇÃO DE CONTRIBUIÇÃO:

MLF: Prepared the material, collected data, analysed and wrote the first draft of the manuscript

AFP and RTM: Prepared the material, collected data and analysed

All authors contributed to the study conception and design, commented on previous versions of the manuscript. All authors read and approved the final manuscript.

RESPONSABILIDADES ÉTICAS

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.

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Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.

Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia revista em 2013 e da Associação Médica Mundial.

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ETHICAL DISCLOSURES

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Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.

Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2013).

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