Original Article

Does Combined Usage of FFP2 and Surgical Mask Against SARS-CoV-2 Affect SpO_2 Values and Pulse Rates of Dental Health-Care Workers?

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Abstract

Background and Aim: Combined use of surgical mask with filtering facepiece (FFP) 2 masks has been popular among the health-care workers. However, the effect of this preference on the vital values of individuals stays as a challenge among the professionals. The present study aimed to assess the effect of FFP2 mask versus combined use of it with surgical mask on the SpO_2 values and pulse rates of individuals. **Patients and Methods:** This study was conducted on 20 health-care workers. The pulse rates and SpO_2 values were evaluated by pulse oximeter placed in the index fingers of the participants. The participants were divided into two groups: those using the FFP2 mask and those using FFP2–surgical mask combination. Individuals wearing FFP2 mask were examined for a period of 60 min and the same examination was repeated for another period of 60 min in those using combination of FFP2 with surgical mask. The values were measured at the beginning and at 15, 30, 45, and 60 min intervals, respectively. The examinations were conducted in the rest position to obtain standardization. **Results:** The observed data showed no statistical difference at all periods in either SpO_2 values or pulse rates between FFP2 and FFP2–surgical mask combined groups. The SpO_2 values reduced from the initial time to 15 min in the FFP2–surgical mask group. Also, in the FFP2–SM group, statistically significant increase in values was observed between 15 and 45 min and 15 and 60 min. Another increase in SpO_2 value was found in the observations made between made 30 and 45 min in the same group ($P < 0.05$). The pulse rates of the individuals showed no statistical difference in both the groups and at all experimental periods ($P > 0.05$). **Conclusion:** According to the present study, wearing only the FFP2 mask or FFP2–surgical mask combination seems not to cause any effect on the SpO_2 values and pulse rates of the participants.

Keywords: *COVID-19, dentistry, face masks, pulse rate, respiratory, SpO_2*

Introduction

The importance and necessity of using protective equipment and masks have increased during the coronavirus disease 2019 (COVID-19) pandemic period, which has affected the whole world.[1] Dental clinics are the highest risk areas of direct exposure to possible infected droplets spreading from the patients. Before the COVID-19 pandemic, clinicians were using traditional surgical masks (SMs).[2-4] During the COVID-19 pandemic period, the protection of SMs previously used in potential areas where the patients are likely to be exposed to infected respiratory tract droplets, including dentistry, has been found to be insufficient. Therefore, more advanced protective equipment may be needed, like filtering facepiece (FFP) 2 face masks.[1,5,6]

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EN 149 is a European standard of testing and marking requirements for filtering half masks.[7] Such masks cover the nose, mouth, and chin and may have inhalation and/or exhalation valves.[7] EN 149 defines three classes of particle half masks called FFP1, FFP2, and FFP3, according to their filtering efficiency. It also classifies masks into "single shift use only" (not reusable, marked NR) or "reusable (more than one shift)" (marked R), and an additional marking letter D indicates that a mask has passed an optional clogging test using dolomite dust. Such mechanical filter respirators protect against the inhalation of particulates such as dust particles, droplets, and aerosols. Similar standards are used in the USA, China, and Japan. For example, EN 149 FFP2 masks have similar performance requirements to N95 masks in the USA and KN95 filters in China.[8]

There has been a trend about using SMs over FFP2 masks among health-care workers. The reason for this was that, during the pandemic period, wherein the viral infection led to acute respiratory syndromes, there were concerns that manufacturers might not be able to provide the demanded amount and there might be difficulties in accessing FFP2 masks. Therefore, it has been stated as an effort to increase the lifetime of the FFP2 mask.[9,10]

There have been many studies on the protective effect of SMs and FFP2 masks and the efficacy of these on the respiratory system.[1,2,5,6,9-12] However, the effect of using an SM in combination with an FFP2 mask on the user's vital signs is not well documented. The study aims to observe the difference in vital signs of resting volunteers according to the reduction of respiratory intake on using the FFP2 mask only and FFP2–SM in combination. The hypothesis of the study was the usage of FFP2 masks only and the FFP2–SM combination might lead to a decrease in the quality of the respiratory functions.

Materials and Methods

The current study had been planned on 20 health-care workers (four male, 16 female) who were aged between 25 and 45 years and had no systemic comorbidity. The informed consent form had signed by all volunteers who were involved in the study. The study was held in accordance with the Helsinki Declaration, including all its amendments and revisions. Access to data was restricted to the researchers. Ethical permission was obtained from the Health Sciences University Gulhane Scientific Researches Ethical Committee (2020-470/17.12.2020).

The exclusion criteria for the study were patients with systemic disorders and pregnant women. For standardization, all the values were collected during the rest position with a pulse oximeter placed in the index finger of participants (Bauer GmbH P1080; Ulm, Germany). The SpO_2 and pulse rate values had been recorded at the beginning and at 15, 30, 45, and 60 min intervals, respectively. The records were obtained by the same researcher. The measurements were made twice in the two groups, which are FFP2 mask only and FFP2–SM combined groups.

Statistical analyses

Statistical analyses were performed by using IBM Statistical Package for the Social Sciences (SPSS) 21 (IBM, Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation, and categorical variables were summarized as frequency and percentage. The normality of the continuous variables was evaluated with the Shapiro–Wilk test. Differences between the groups for dependent variables were determined by repeated-measures analysis of variance (ANOVA) or Friedman test as appropriate. Bonferroni adjustment was used for multiple comparisons. A P value less than 0.05 was considered significant.

Table 1: The age groups and the gender of the individuals

Variables	*n*±SD/*n* (%)
Age	32.15±8.53
Age group	
<30	12 (60%)
≥30	8 (40%)
Gender	
Male	4 (20%)
Female	16 (80%)
BMI	23.96±5.00

BMI=Body mass index

Table 2: The differences with the Mask 1 and Mask 2 groups related to SPO_2 and Pulse values

Variables	Mean±SD		*P*
	FFP2	FFP2-SM	
SpO_2			
Time 0	96.80±1.28	96.45±1.47[a]	0.260
Time 15	96.40±1.60	95.80±1.82[a,b,c]	0.175
Time 30	96.05±1.67	96.10±2.13[d]	0.899
Time 45	96.45±1.50	96.65±1.76[b,d]	0.530
Time 60	96.55±1.40	96.75±1.33[c]	0.551
P	0.177	0.046*	
Pulse			
Time 0	82.40±13.39	89.50±16.08	0.068
Time 15	82.75±10.75	85.50±13.55	0.245
Time 30	79.80±11.44	82.90±12.18	0.255
Time 45	81.65±11.52	84.35±10.47	0.224
Time 60	82.95±9.29	83.50±13.99	0.850
P	0.180	0.112	

Similar uppercase shows significant differences in the same column (**P*<0.05)

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Results

The age group and gender of the individuals are given in Table 1. According to Table 1, eight participants were over 30 years of age and 12 participants were between 20 and 30 years of age.

The SpO_2 values and pulse rates of the individuals are shown in Table 2. The pulse rates of the individuals showed no statistical difference in both the groups and at all experimental periods ($P > 0.05$). The SpO_2 values reduced from the initial time to 15 min in the FFP2–SM group. Also, in the FFP2–SM group, statistically significant increase was observed between the time periods of 15 and 45 min and 15 and 60 min. Another increase in SpO_2 value was detected in the observations made between 30 and 45 min in the same group ($P < 0.05$). There was no statistical difference in the SpO_2 rates of individuals in the FFP2 group in all time periods ($P > 0.05$).

Discussion

The hypothesis of this study was the combined use of FFP2 mask and SM might affect the respiratory quality of the health workers. Accordingly, the SpO_2 values and pulse rates of individuals were evaluated. The primary outcome of the study revealed that, the pulse rates and SpO_2 values were not affected statistically between FFP2 and FFP2–SM groups at all experiment periods ($P > 0.05$). Accordingly, the hypothesis was rejected.

The vital signs related to respiratory activity could be measured by monitoring the heart rate, breathing rate, and tidal volume by physiological sensors and respiratory inductive plethysmography bands or by a pulse oximeter. In the literature search, it was found that pulse oximeter has been used in several studies that have aimed to observe respiratory activity.[13-15] In this study, a pulse oximeter was chosen due to its uncomplicated and simple usage.

This study was conducted on 20 healthy participants. The power analyses were used to determine the number of participants according to a previous study con ducted by Roberge *et al.*,[10] in which 10 volunteers were selected. It was a challenge to obtain standardization during dental procedures. The time of the dental procedure and the type of treatment might be different for each patient. In this situation, the participants' vital signs were recorded during their rest position to obtain standardization.

The aerosol filtration percentage of FFP2 masks is not less than 94%. The internal leak rate of FFP2 masks goes to a maximum of 8%. This mask offers protection in various areas such as glass industry, foundry, construction, pharmaceutical industry, and agriculture. It effectively stops powdered chemicals. This mask can also serve as protection against respiratory viruses such as avian influenza or severe acute respiratory syndrome associated with the coronavirus (SARS), as well as against the bacteria of pneumonic plague and tuberculosis. It is similar to the N95 mask.[9] Therefore, in this study, studies on N95 were also included.

Roberge *et al.*[10] conducted a study in which an SM was worn over an N95 FFP respirator by 10 health-care workers for 1 h at each of two work rates. Volunteers were standardized by effort test (treadmill walk- 1 h). Heart rate, respiratory rate, tidal volume, minute volume, oxygen saturation, transcutaneous carbon dioxide levels, and respiratory dead space gases were monitored and compared to controls (N95 FFP respirator without an SM). The study showed no statistical difference between the N95 and N95–SM groups.[10] This finding was similar to that of the present study.

According to the results of the present study, the SpO_2 values showed no statistical difference in the FFP2 group. However, there was a reduction in SpO_2 values in the first 15 min in the FFP2–SM group. An increase was observed in the subsequent measurements at 30, 45, and 60 min, respectively, in the same group. This increase in the SpO2 group resulted from the hypoxic ventilatory response due to respiratory plasticity. According to the theory of hypoxic ventilatory response, when the partial pressure of oxygen decreases, the activity of chemoreceptors causes an immediate increase in ventilation.[16,17] Based to these results, it can be concluded that the hypothesis of the study was rejected.

Although the pulse rate of the volunteers was expected to increase for compensating SpO_2 reduction, it was found that the pulse rate did not change from the initial time to the end of the measurements. The reduction of the SpO_2 rate was not enough to activate the pulse rate mechanism. The proposed mechanism included signals arising from the cortex (so-called feedforward control), temperature increases, afferent signals arising as a result of muscle contraction (locomotor muscle afferents and respiratory muscle metaboreflex), accumulation of catecholamines, and increases in potassium in the venous blood.[18]

In a similar study, Fikenzer *et al.*[19] studied FFP2 mask, SM, and no mask on 12 male individuals (age 38.1 ± 6.2 years, body mass index [BMI] 24.5 ± 2.0 kg/m^2). In their study, they observed significantly lower forced expiratory volume in the groups with mask. However, cardiac output was similar in groups with and without a mask. Health-care workers usually suffer as they cannot breathe when they use the FFP2 mask or FFP2–SM mask combination. Apart from this suffering, the present study showed that there was no adverse effect on SPO_2 values and pulse rates due to combined usage. The reduced volume of breath may

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cause this suffering through the two barriers of FFP2 and SM. The brain may give signals to the body that there is a reduction in the breath volume intake. This signal may cause a psychological feeling of insufficient breathing.

In addition to all these findings, smoking cigarettes and obesity may affect the respiratory functions of individuals.[17,18,20-22] In these groups of people, wearing FFP2–SM together might cause differences in the vital signs. However, the number of smokers or the number of obese volunteers was insufficient to obtain a statistical analysis in this study. Further investigations are needed, including a greater number of participants of this group of health-care workers, and these can be stated as the limitations of the study.

Conclusion

According to the present study, wearing only the FFP2 mask or FFP2–SM combined mask does not cause any effect on SpO_2 values and the pulse rates of the participants. However, there are some concerns about the results of smokers and obese individuals. Therefore, this study is needed to be repeated with an extended population that includes smokers and obese volunteers also.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (from the Health Sciences University Gulhane Scientific Researches Ethical Committee [2020-470/17.12.2020]) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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