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RESEARCH NOTE

COVID-19 pandemic: do surgical masks impact respiratory nasal functions?

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KEYWORDS
COVID-19, face mask, nasal mucosa, nasal respiratory functions, rhinomanometry

1 | INTRODUCTION

Because of coronavirus disease-19 (COVID-19), the use of surgical masks has become a worldwide recommendation[1]; however, this has encountered some resistance in the general population, justified by complaints of nasal discomfort.[2] To date, the functional and architectural impacts of wearing a surgical mask on nasal respiratory functions have not been investigated.

The objective of this prospective study was to evaluate any consequences of surgical mask use on nasal respiratory functions and geometry, as measured by rhinomanometry, acoustic rhinometry, and nasal compliance.

2 | PATIENTS AND METHODS

We conducted a prospective, monocentric study including adult volunteers without septal perforations or complete nasal obstruction (medical and paramedical staff of a French teaching hospital, and patients scheduled for rhinomanometry) between January and April 2021.

Questionnaires and measurements were performed 3 times: (i) T1—after 30 minutes of wearing a mask and with the mask still on, each volunteer was asked to complete a visual analog scale (VAS) questionnaire of nasal discomfort symptoms (nasal obstruction, rhinorrhea, pruritus, shortness of breath, sweating, and mouth breathing), followed by nasal entrance temperature anterior rhinomanometry, acoustic rhinometry, and nasal compliance measurements immediately after the mask was removed; (ii) T2—the volunteer then spent 30 minutes without a mask on, and thereafter, completed the same questionnaires and measurements; and (iii) T3—the volunteer put the mask back on and immediately underwent anterior rhinomanometry to assess the barrier resistance generated by the surgical mask itself (Fig. S1). As recommended in the Riga Conference consensus,[3] the logarithmic effective resistances (LReff) were chosen to evaluate the pressure flow recorded by anterior rhinomanometry (low and very low LReff < 0.89 Pa.ml^{-1}.s; high and very high LReff > 1.09 Pa.ml^{-1}.s). Methods are detailed in the Supporting Information available online.

TABLE 1 Visual analog scale evaluation of subjective symptoms with/without a mask for 30 minutes

VAS evaluation item	With a mask for 30 minutes	Without a mask for 30 minutes	*p* value
Headache	0.72 ± 1.70	0.18 ± 0.77	0.009
Mouth breathing predominant	2.70 ± 3.18	0.46 ± 1.03	<0.0001
Sweating	2.38 ± 2.91	0.22 ± 0.91	<0.0001
Respiratory oppression	1.60 ± 2.24	0.10 ± 0.36	<0.0001
Pruritus	1.28 ± 1.94	0.06 ± 0.31	<0.0001
Rhinorrhea	1.68 ± 2.29	0.48 ± 1.22	0.001

notes: Data expressed as mean ± standard deviation. Visual analog scale (VAS) maximum score = 10.

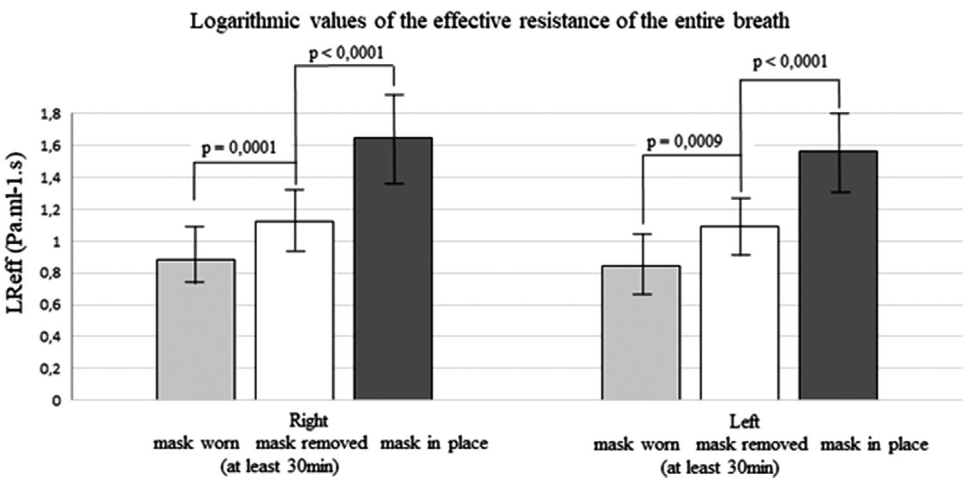

FIGURE 1 Logarithmic values of the effective resistance of the entire breath (LReff) in patients with a mask for 30 minutes (T1) compared with LReff values without a mask for 30 minutes (T2), and to LReff values with a face mask covering the nose (T3). Fifty adult patients were assessed. Data expressed as mean ± standard deviation (error bars).

3 | RESULTS

For the 50 adult volunteers included (characteristics in Table S1), the nasal obstruction VAS (highest score = 10) for the right nasal fossa was significantly higher at T1, compared with the VAS at T2: 1.8 ± 2.1 and 1.3 ± 1.9, respectively ($p = 0.012$). The VASs of other symptoms (headaches, mouth breathing, sweating, respiratory oppression, pruritus, and rhinorrhea) (highest score = 10) were significantly higher at T1 than at T2 (Table 1). LReff at T1 was significantly reduced (right = 0.89 ± 0.33 $Pa.ml^{-1}.s$; left = 0.84 ± 0.37 $Pa.ml^{-1}.s$) compared with LReff at T2 (right: 1.12 ± 0.36 $Pa.ml^{-1}.s$; left: 1.09 ± 0.33 $Pa.ml^{-1}.s$) (right and left nasal fossae: $p < 0.001$). LReff with the masks re-donned (T3) were significantly increased (right: 1.64 ± 0.48 $Pa.ml^{-1}.s$; left: 1.56 ± 0.46 $Pa.ml^{-1}.s$) compared with LReff at T2 (right and left nasal fossae: $p < 0.0001$) (Fig. 1).

The Minimal Cross-sectional Area (MCA)-1 at T1 was significantly larger (right: 0.62 ± 0.21 cm^2; left = 0.67 ± 0.21 cm^2) than that at T2 (right: 0.48 ± 0.18 cm^2; left = 0.52 ± 0.26 cm^2) (right and left nasal fossae: $p < 0.0001$) (Fig. S2).

Nasal compliance at C1 was significantly higher at T1 than T2 (0.02 ± 0.019 and 0.017 ± 0.013 cm^2/cmH_20, respectively; $p = 0.036$) (Fig. S3).

The temperature at the nasal entrance was significantly higher at T1 (31.2 ± 1.00°C) than it was at T2 (27.9 ± 1.60°C; $p < 0.0001$).

4 | DISCUSSION

Wearing a surgical mask provides positive effects on functional nasal respiratory parameters. LReff was significantly reduced after wearing a mask for 30 minutes, while MCA-1 and compliance at the nasal valve were significantly higher. Rarely (if ever) are the cross-sectional nasal areas and rhinomanometry scores inaccurate when people complain about mask usage. People typically complain about subjective matters, as expected.[4]

Scarano et al reported increased humidity behind masks[5] and we reported significantly warmer temperatures (mean, +3.4°C). When the nose is exposed to cool, dry air, the nasal mucosa releases vasoactive amines and leukotrienes[6,7] that increase both superficial mucosal blood flow, which, in turn, leads to increased nasal resistances.[8] When wearing a mask, the exhaled air, instead of being cooled away from the nasal vestibule, warms newly the inhaled air. As a result, LReff and areas of sections are decreased when wearing a mask.

The VAS-assessed worsening of rhinologic symptoms when wearing a mask in our study is in line with the meta-analysis performed by Kisielinski et al.[9] These observations point to a discordance between the discomfort expressed by a subject when wearing a mask for 30 minutes (lower VAS score) and the aforementioned positive effects of doing so on the subject's nasal mucosa (significantly reduced LReff in between T2 and T1). This paradoxical result may be explained by the fact that the first LReff measurements (T1) were performed with no tissue interposing between the nasal fossa and the rhinomanometer. At T3, the rhinomanometer applied on the mask reduced the effective surface used to breath, which explains the increase of LReff.

There are some limitations to our study. First, we chose healthy volunteers as subjects, among whom a majority are health-care workers and more used to wear surgical masks for multiple hours per day. Second, the measurements' sequence (T1, T2, T3) was not randomized. Indeed, regarding the worldwide sanitary crisis (mask required to enter the hospital), it was impossible to perform measurements before any mask use. Prospective studies are needed on patients with chronic rhinologic symptoms and with use of other types of masks (cloth, surgical masks, N95, KN95, etc) as well as on the longer term impacts of wearing face masks and the related physiologic changes on nasal mucosa.

CONFLICTS OF INTEREST

None.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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