Covid-19 outbreak: does the use of a surgical mask impact the sense of smell? A crossover prospective comparative study

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Abstract

- We hypothesized that the surgical mask could filter some odorant particles, leading to a transient hyposmia. - A crossover prospective comparative study between 2 groups of 10 healthy volunteers was conducted to evaluate the impact of wearing a surgical mask on sense of smell by comparing the results of sniffin' sticks test (SST) with and without a surgical mask. - All the subjects, except one, had a significantly better total score (TDI) without a mask. - 4/20 (20%) were normosmic without a mask, while being recategorized as hyposmic with a mask. - Wearing a surgical mask may reduce the sense of smell, in a cohort of young normosmic patients.

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Key points:

- We hypothesized that the surgical mask could filter some odorant particles, leading to a transient hyposmia.
- A crossover prospective comparative study between 2 groups of 10 healthy volunteers was conducted to evaluate the impact of wearing a surgical mask on sense of smell by comparing the results of sniffin' sticks test (SST) with and without a surgical mask.
- All the subjects, except one, had a significantly better total score (TDI) without a mask.
- 4/20 (20%) were normosmic without a mask, while being recategorized as hyposmic with a mask.

- Wearing a surgical mask may reduce the sense of smell, in a cohort of young normosmic patients.

Introduction

Coronavirus disease 19 (Covid-19) has spread since December 2019, due to a coronavirus transmitted from human to human through airway secretions (1).

To limit transmission of the virus, surgical masks are recommended worldwide as a filter to avoid propagation of SARS-CoV-2 by airborne droplets (1). In Oto-rhino-laryngology departments, we noticed an increase of complaints of daily discomfort, especially a loss of smell attributed to the mask (2). Some of these people were health care staff, who must wear a face mask for hours. It could be an added stress factor in this period with high psychological impact for healthcare workers (3). We hypothesize that the mask could filter some odorant particles, leading to a transient hyposmia.

A well-recognized tool for assessing olfactory performances is the sniffin' stick test (SST) which consists in smelling scent pens to determine 1) an olfactory threshold, 2) a score of discrimination and 3) an identification score (4).

The purpose of this pilot study was to compare the results of SST with and without a mask in a population of self-reported normosmic volunteers to evaluate any consequence of wearing a surgical mask on the sense of smell.

Materials and methods

Study design

We followed STROBE guidelines for this monocentric prospective comparative study. Participants were randomly assigned following simple randomization procedures (computerized random numbers) to 1 of 2 crossover groups: group 1 first performed SST with a surgical mask and then one week later performed SST without a mask, while group 2 first performed SST without a surgical mask and then one week later performed SST with a mask.

Ethical considerations

Ethical approval was granted by the local Ethics Committee (Agreement 2021-01-02). Written informed consent was obtained from all individual participants.

Study population

All the participants in this study were medical doctors and students from an academic oto-rhino-laryngology department. The inclusion criteria were, on a voluntary basis: sense of smell considered as normal without a mask (subjective self-reporting); informed consent and non-opposition were obtained. An earlier 48-hour negative Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) for the SARS-CoV-2 on nasopharyngeal swabs was needed.

The exclusion criteria were a history of chronic or acute rhinosinusitis disease, history of craniofacial trauma, history of radio or chemotherapy of the head and neck sphere, symptomatology consistent with SARS-CoV-2 one month or less before the test or recent contact case.

Data collection and SST

Before each test, patients responded to a questionnaire containing their personal and medical history, including nasosinusal and olfactory symptoms. Face masks used were surgical masks NF EN 14683.

The SST consisted in smelling pens blindly, with odorant pens placed for 3-4 seconds within 2cm of the nostrils (5). It was divided into three sub-tests: a threshold test (T), a discrimination test (D) and an identification test (I), each with a score of 16, and therefore a total score of 48 (TDI). According to TDI, patients were considered as normosmic (TDI>30.5), anosmic (TDI<16.5) or hyposmic (TDI between 16.5 and 30.5) (5). The score was calculated by a software called Olaf ®.

Statistical analysis

Statistical tests were performed using the IBM SPSS Statistics 20. Continuous values were expressed with their average number ± Standard Deviation (SD) and categorical values as numbers and percentages. The intra-group results with and without masks were compared using a paired non-parametric test. A significant difference was considered for $p<0.05$.

Average results for each test and each sub-test were calculated. 60% of subjects with TDI change of 5.5 or more will report clinical olfactory change, so a difference in TDI scores with and without a mask less or equal to 5 was considered as not clinically relevant (6). Differences in T, D and I scores with and without a mask were considered of clinical significance when superior to 2.5, 3, and 3, respectively (6).

The inter-group results were compared with a Mann Whitney test.

Results

Cohort

Between March 2020 and March 2021, 20 healthy volunteers were included in the study. Characteristics of the volunteers are described in Table 1.

Sniffin' Stick Test

Intra-group comparison

In group 1 and 2, all the subjects were normosmic without a mask, except for two subjects who were hyposmic (Table 2). The two hyposmic subjects (respectively 49 and 52 years old) had a TDI of 28.5 for subject 1 and 27.5 for subject 2.

All the subjects, except one, experienced a significant decreased olfactory performance when wearing a mask ($p=0.02$) (Figure 1).

The average difference observed with and without a mask were inferior to 5 for both group 1 and 2 (respectively 3.77 and 4.87), being non-clinically relevant. Nevertheless, 8 participants (40%, 35±13 years old) had a TDI difference with and without a mask superior to 5. Among them, four participants (one in group 1 and 3 in group 2, 38±19 years old) were normosmic without a mask (TDI superior to 30.5, average TDI of 34.9±1.1), while being recategorized as hyposmic with a mask (TDI inferior to 30, average TDI of 27.8±0.6). For the 4 other participants with a TDI difference with and without mask superior to 5 (average TDI difference of 6.25±1.2, 33±6 years old), they were normosmic with and without a mask: average TDI of 35.3±1.6 and 41.6±1.1 respectively.

The identification test appeared to be the less impacted sub-test when wearing a mask (Table 2). The difference in threshold tests with and without a mask was greater in group 2 than in group 1 (2,08 and 1,48 respectively), but without clinically impact (difference in T-score<2.5). The difference in discrimination test with and without a mask was greater in group 2 than in group 1 (3,3 and 1,9 respectively), with only clinical significance in group 2 (difference in D-score>3).

Inter-group comparison

The differences in average total scores between group 1 and 2 were compared using a Mann Whitney Test and were not statistically significant ($p=0.57$).

Discussion

Our study shows that wearing a surgical mask may reduce the result of SST in a cohort study of young patients without any olfactory dysfunction. All the subjects, except one, had a significantly better total score (TDI) without a mask. The average standard deviation for the TDI score with and without a mask, was inferior to 5, making it non clinically relevant (6). Nevertheless, for 8/20 subjects (40%) the TDI difference

with and without mask was superior to 5. Moreover, 4/20 subjects (20%) of the participants normosmic without a mask, became hyposmic with a mask.

With the Covid-19 pandemic, wearing a mask in daily life has become a worldwide recommendation (1). The potential decrease in the sense of smell by wearing a mask must be evaluated, because of its impact on the quality of daily and professional life.

The pathophysiological mechanism of this mask-induced hyposmia is unclear. Considering that the filter of a surgical mask blocks particles greater than 0.9 µm (7), while odorous particles are nanomometer sized, the hypothesis of a particle-filtering barrier cannot be retained. Another hypothesis would be the reduction of the air flow reaching the olfactory cleft. Besides the direct filtration of particles, the protective effect of the mask is also based on electrostatic deposition, occurring due to a charge difference between a fiber and a particle (8). Odorant molecules are electrically charged and could be blocked by the mask, also electrically charged.

The most impacted sub-test was the discrimination test, while threshold and identification tests were less impacted. The mask could filter some odorant particles and not others, according to their molecular size and electric charge. The identification test was the less impacted sub-test because odor identification requires not only odor perception but also a cognitive function (9).

Chen et al., in a comparative study with and without a mask, noticed a preserved odor-identification with a decreased T-score (10). Nevertheless, they did not perform a discrimination sub-test, thus risking underestimating the impact of a mask on olfaction (10).

We decided not to perform a quality-of-life questionnaire, because not applicable for a reversible acute problem. Nevertheless, imagining a chronic sensory hypostimulation, future investigations would be interesting to know if daily face mask use, over a period of years, has a definitive impact on olfaction. The impact of mask must also be evaluated to assess if the chronic use of a mask could potentially reduce or slow down the olfaction recovery in case of Covid-19 dysosmia.

Our study has some limitations. Firstly, our study is a pilot study, which explains the small number of patients. Secondly, our population was young and mostly normosmic. Future studies with older patients as well as hyposmic patients and quality of life questionnaires would be interesting.

Conclusion

The present pilot study compares SST with and without a mask. Our results suggest that wearing a surgical mask may have an impact on smell, even in a young normosmic population. Other studies must be performed to assess a potential long-term impact of masks on the sense of smell and its related impact on quality of life.

References

1. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. JAMA. 2020 Aug 25;324(8):782–93.

2. Scheid JL, Lupien SP, Ford GS, West SL. Commentary: Physiological and Psychological Impact of Face Mask Usage during the COVID-19 Pandemic. Int J Environ Res Public Health. 2020 Sep 12;17(18).

3. Kisely S, Warren N, McMahon L, Dalais C, Henry I, Siskind D. Occurrence, prevention, and management of the psychological effects of emerging virus outbreaks on healthcare workers: rapid review and meta-analysis. BMJ. 2020 May 5;369:m1642.

4. Hummel T, Kobal G, Gudziol H, Mackay-Sim A. Normative data for the "Sniffin' Sticks" including tests of odor identification, odor discrimination, and olfactory thresholds: an upgrade based on a group of more than 3,000 subjects. Eur Arch Otorhinolaryngol. 2007 Mar;264(3):237–43.

5. Hummel T, Sekinger B, Wolf SR, Pauli E, Kobal G. "Sniffin" sticks': olfactory performance assessed by the combined testing of odor identification, odor discrimination and olfactory threshold. Chem Senses. 1997 Feb;22(1):39–52.

6. Gudziol V, Lötsch J, Hähner A, Zahnert T, Hummel T. Clinical significance of results from olfactory testing. Laryngoscope. 2006 Oct;116(10):1858–63.

7. Oberg T, Brosseau LM. Surgical mask filter and fit performance. Am J Infect Control. 2008 May;36(4):276–82.

8. Zangmeister CD, Radney JG, Vicenzi EP, Weaver JL. Filtration Efficiencies of Nanoscale Aerosol by Cloth Mask Materials Used to Slow the Spread of SARS-CoV-2. ACS Nano. 2020 Jul 28;14(7):9188–200.

9. Chen B, Zhong X, Mai N, Peng Q, Wu Z, Ouyang C, et al. Cognitive Impairment and Structural Abnormalities in Late Life Depression with Olfactory Identification Impairment: an Alzheimer's Disease-Like Pattern. Int J Neuropsychopharmacol. 2018 Jul 1;21(7):640–8.

10. Chen B, Wang Q, Zhong X, Heyne L, Ning Y, Hummel T. Can we assess the sense of smell through a face mask? Int Forum Allergy Rhinol. 2020 Nov;10(11):1264–5.

TABLES

Table 1: Characteristics of the 20 volunteers.

Characteristics	**Group 1, n=10**	**Group 2, n=10**
Age, mean (SD), years	30.5 (8.9)	36.3(12.66)
Male, No. (%)	4 (40)	4 (40)
Regular Smokers, No. (%)	2 (20)	4 (40)
Rhinological symptoms, No. (%)	0 (0)	0 (0)

Continuous values are expressed as average number (± standard deviation (SD)) and categorical ones as numbers (percentage). No.=number.

Table 2: Comparison of TDI score and subtests with and without mask in group 1 and group 2.

	TDI with a mask, mean (SD)	**TDI without a mask, mean (SD)**	**P value**	**T with a mask, mean (SD)**	**T without a mask, mean (SD)**	**P value**	**D with a mask, mean (SD)**	**D without a mask, mean (SD)**	**P value**	**I with a mask, mean (SD)**	**I without a mask, mean (SD)**	**P**
Group 1	34.03 (5.6)	37.8 (5.82)	0.0215	8.72 (2.8)	10.2 (3.4)	0.109	11.9 (2.68)	13.8 (2.1)	0.004	13.4 (1.64)	13.8 (1.54)	0
Group 2	31.35 (4.44)	36.22 (3.92)	0.0020	6.5 (3.48)	8.6 (3.15)	0.021	10.4 (1.71)	13.7 (1.41)	0.02	14.4 (1.17)	13.9 (0.99)	0

Values are average scores of the threshold test (T), the discrimination test (D) and the identification score (I) ± SD (standard deviation), and p value calculated according to the Wilcoxon test (p was considered significant for $p<0.05$).

Figure 1 : Comparison of the TDI scores with and without a mask for each participant in Group 1 (n=10) and 2 (n=10).

Values are total TDI scores for each subject. TDI: threshold (T), discrimination (D) and identification (I)

score.

The dotted line refers to the only subject with increased olfactory performance with a mask.

: mean value of TDI scores with and without a mask;

: TDI difference with and without a mask >5;

: TDI difference with and without a mask [?]5

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