

CLINICAL EXPERIENCE

Influence of a surgical mask on voice analysis in healthy subjects in the COVID-19 pandemic: A cross-over study

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) is a worldwide pandemic associated with more than 241 million¹ infected individuals and 4.9 million deaths.¹

In most healthcare facilities, personal protective equipment (PPE) measures are important to protect healthcare workers, and include the hand disinfection and the use of masks. The use of filtering facepiece 2 (FFP2) or surgical masks was implemented in many countries for citizens and remains an important rule, in conjunction with ongoing vaccination campaigns. In the present study, we assessed the impact of surgical mask (SM) on voice quality analyses. Precisely, we compared the acoustic parameter findings of healthy participants according to the use of surgical mask through a cross-over study.

2 | METHODS

2.1 | Reporting guidelines

CONSORT guidelines were applied.

2.2 | Participants

Healthy subjects were consecutively recruited from both hospital staff of the Department of Otolaryngology (Charleroi, Belgium) and volunteers who were visiting patients in the hospital or an accompanying person. The following criteria were used to consider subject as a healthy individual: no self-reported voice disorder the week before the examination (laryngopharyngeal infection, etc.), normal videolar-yngostroboscopy and no perceptual dysphonia (GRBAS score of GORBOAOS0). Subjects with histories of laryngeal surgery, upper respiratory tract infection within the last month, asthma, chronic obstructive pulmonary disease (COPD), restrictive pulmonary syndrome, head and neck cancer, gastroesophageal or laryngopharyngeal reflux, alcohol or tobacco consumption in the 24 h before the examination and recent COVID-19 were excluded. To be considered as a negative COVID-19 subject, they did not report COVID-19-related symptoms and in case of doubt, the RT-PCR had to be negative in the last 2 months.

All professional voice users were also excluded.

Key Points

1. Voice analysis is an essential examination in the workup of a dysphonic patient.
2. As the COVID-19 pandemic continues, it is imperative to assess more chronic pathologies.
3. The removal of the mask by the patient during examination could contribute to contaminating the medical equipment or the examiner and subsequently other patients.
4. The wearing of a surgical mask does not influence voice analysis on healthy subjects.
5. Voice analysis should be performed on patients with vocal disorders with and without mask in future studies.

2.3 | Voice quality evaluations

Participant underwent a baseline endonasal laryngeal videostroboscopy (Olympus ENF), without local anaesthetic, to exclude laryngeal disorder and benefited from two voice analyses with phonetogram and sonogram (DiVAS - Digital Video Archive software- Voice Diagnostics System from XION GmbH) with and without surgical mask. The XION microphone is with automatic calibration and is placed at a constant distance of 30 cm (headset). As a result, the distance between the patient's mouth and the microphone and the positioning remain constant at all times. When the patient turns his head, the microphone rotates, which ensures stable recording. The headset's built-in electronics ensure automatic calibration of the microphone. It has automatic noise cancellation and a separate display of the ambient sound in the voice profile. The running order of voice analysis was randomised (with vs. without mask). The parameters analysed included fundamental frequency (F0), maximum frequency (Fmax), range in amplitude (RA) and frequency (RF) of the voice, percent jitter, dysphonia severity index (DSI) and maximum phonation time (MPT). To ensure uniformity, the voice analysis and videostroboscopy were performed on the same day for each individual. Only one ENT specialist (the R.M.) performed the videostroboscopy. Two speech language pathologists executed the voice analysis. A new surgical mask was delivered before each testing. Prior mask-wearing behaviour was not recorded in this study. All data were collected in a time frame of 4 months (2021), outside a COVID vague.

TABLE 1 Descriptive data of the studied vocal parameters and statistical comparisons of these according to the wearing of the mask or not (SM+/SM-)

Voice parameter	SM	Median	Q1-Q3	<i>p</i>
F0 (Hz)	SM+	151	128.5-205.75	0.304
F0 (Hz)	SM-	145.5	123.5-221.75	
Fmax (Hz)	SM+	471	245.5-621.5	0.324
Fmax (Hz)	SM-	469	258.75-558.25	
Jitter (%)	SM+	59	48-86.5	0.254
Jitter (%)	SM-	71	52-85.5	
RF (Hz)	SM+	332	159.5-448.75	0.481
RF (Hz)	SM-	331	173.5-401.5	
RA (dB)	SM+	35	32-36.75	0.165
RA (dB)	SM-	36.5	32.5-38	
MPT (s)	SM+	17.75	14.025-19.925	0.440
MPT (s)	SM-	17.10	14.775-20.95	
DSI	SM+	1.89	0.5075-2.4925	0.478
DSI	SM-	1.69	0.87-2.37	

Abbreviations: DSI, dysphonia severity index; F0, fundamental frequency; Fmax, maximum frequency; MPT, maximum phonation time; Q, quartile; RA, range in amplitude of the voice sample; RF, range in frequency of the voice sample; SM, surgical mask.

2.4 | Surgical mask

A Kimberly-Clark Technol 49214 pleated SM (Kimberly-Clark), constructed of three hydrophobic polypropylene layers, was selected for the study because the company has a leading US market share for SM in healthcare (Kimberly-Clark, 1999) and this product has been used in recent experiments that have demonstrated its protective and physiological effects.²

2.5 | Statistical analysis

Statistical analyses were performed using the software IBM SPSS Statistics version 23.0 (IBM). Continuous variables were described using means and SDs or medians and inter-quartile ranges according to the normality of parent distributions. Normality was assessed using QQ plots and Shapiro-Wilk tests. Continuous variables were compared using non-parametric and parametric procedures for paired data (Wilcoxon signed-rank tests and paired *t* tests). A *p* < 0.05 was considered significant.

3 | RESULTS

Twenty subjects completed the study (10 males and 10 females). The mean age was 36.7 years (range, 21-65 years). The median was 32.0 years. Tables 1 and 2 showed that the mask did not modify the acoustic and aerodynamic measurement findings. In addition, we did not observe any modification of the recorded parameters according to the running order (Table 2).

4 | DISCUSSION

In 2001, the European Laryngeal Society (ELS) published a basic protocol describing the multidimensional voice quality evaluations.³ Objective voice quality evaluations are an important part of the evaluation and it was conceivable to investigate whether the mask may affect the acoustic measurements.

The use of face masks by the population is considered to be of high value in curtailing community transmission in the pandemic.⁴ Studies have shown that SM use for 1 h at a low-moderate work rate is not associated with clinically significant physiological impact or significant subjective perceptions of exertion or heat.² In the present study, we showed that the SM does not seem to influence acoustic measurement in a cohort of normal participants. This finding is important for future laryngology consultation because the voice quality evaluations are frequent, and the removal of the SM may be associated with a higher risk of contamination of physician and other patients.

A previous work has reported that there were no significant impacts of SM on acoustic evaluations.⁵ However, our study has gone further to address methodological concerns from this study to reassure clinicians and scientists about drawing similar conclusions.

First, the type of microphone may impact the voice quality measurement results.⁶ We used a XION microphone with automatic calibration placed at a constant distance of 30 cm (headset). The prior study⁵ put subjects in front of a portable USB studio microphone at a distance of 20 cm. This microphone is used for recording podcasting, gaming or streaming and is not used for medical purposes. Maintaining a constant distance and positioning with respect to the microphone during the entire duration of the examination cannot be guaranteed. Calibration or stable positioning prior to their testing was

TABLE 2 Descriptive data of the studied vocal parameters and statistical comparisons of these according to the running order

Voice parameter	Running order	Median	Q1–Q3	<i>p</i>
F0 (Hz)	1	151	125.75–221.25	0.723
F0 (Hz)	2	145.5	128.5–206	
Fmax (Hz)	1	471	245.5–588.25	0.587
Fmax (Hz)	2	469	260.5–617.5	
Jitter (%)	1	65	50.75–89.5	0.338
Jitter (%)	2	68	45.75–82	
RF (Hz)	1	332	149.75–436.75	0.840
RF (Hz)	2	331	176.25–444.5	
RA (dB)	1	35	32–38	0.672
RA (dB)	2	35	31.75–37	
MPT (s)	1	17.85	15–20.6	0.747
MPT (s)	2	16.45	13.875–20.775	
DSI	1	1.91	0.665–2.3125	0.861

Abbreviations: DSI, dysphonia severity index; F0, fundamental frequency; Fmax, maximum frequency; MPT, maximum phonation time; Q, quartile; RA, range in amplitude of the voice sample; RF, range in frequency of the voice sample; SM, surgical mask.

not indicated in their study. The automatic noise cancellation and separate display of the ambient sound in the voice profile of our headset increase the reliability of the measurements.⁷ Our obtained results are therefore reliable and reproducible.

Second, it has been demonstrated that the time interval over which the acoustic parameters are measured has a significant impact on the values of the acoustic measurements. Our study evaluated the acoustic parameters in a time interval of 3 s.⁸ The previous study does not elaborate on this matter.⁵

Voice fatigability effect was prevented in our study by randomising the order of testing with and without an SM. Indeed, Ribeiro et al.⁹ showed that a face mask increases the perception of vocal symptoms and discomfort. A study that realised vocal analysis with an SM arm but no maskless control could have increased this subjective discomfort and vocal fatigue, reducing the quality of the results recorded. There was no randomization process in the previous study, which may limit the result analysis regarding the risk of voice fatigability.

The usage of a standard surgical mask before each testing start, rules out bias from different types of face masks (cloth mask, FFP2 or FFP3). Our study made sure that each participant was examined with the same type of SM which was also a new—just out of the box—SM. The used parameters in consequence cannot be influenced by a used or another type of mask. The previous study did state the use of a surgical mask,⁵ but it is not clear whether all SM were new and from the same manufacturer.

Our inclusion criteria included participants only after confirming by videostroboscopy that no laryngeal lesions were present. The previously mentioned study⁵ was conducted on health professionals only, with a normal history and the absence of vocal complaints, but no videostroboscopy was performed, which further limits direct comparison of our results with the other study.

In our study, statistical analysing was performed to confirm normal distribution. It is not clear whether this was also performed in the previous study.

Nevertheless, the small number of subjects could be a possible limitation to the observation of a significant difference for the different vocal parameters studied. A similar study on a larger number of subjects is necessary to confirm these observations.

The inclusion of only participants with no vocal complaints or laryngeal lesions is also a limitation of the present study. It would be of interest to evaluate a group of participants with voice pathologies. Asiaee et al.¹⁰ already revealed significant changes in the acoustic parameters of voice between patients with COVID-19 and control groups. Changes in the acoustic parameters of voice are caused by insufficient airflow, and increased aperiodicity, irregularity, signal perturbation and level of noise, which are the consequences of pulmonary and laryngological involvements in patients with COVID-19.¹⁰ In the future, we would like to realise vocal analysis in a similar study carried out with FFP2 or FFP3 masks.

5 | CONCLUSION

The surgical mask does not seem to impact the acoustic measurement outcomes performed in laryngology consultation. Future studies with a higher number of participants in the same setting are needed to confirm our results. The potential impact of a surgical mask on recorded voice quality evaluation should also be studied in a group of participants with voice pathology.

AUTHOR CONTRIBUTIONS

Rupal Mehta designed the work. Rupal Mehta, Quentin Mat, Christophe Lelubre acquired and analysed data. Rupal Mehta, Quentin Mat, Christophe Lelubre, Jerome René Lechien and Jean-Pierre Duterme drafted, revised and approved the manuscript. Rupal Mehta, Quentin Mat and Jean-Pierre Duterme agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT


The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

The study was approved by the local IRB (CCB B406202000164) and informed consent was obtained for each subject.

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