

## **Supporting information**

### **Methods**

#### Study population

All of the study's participants were volunteers aged >18 years. Among them were members of the medical and paramedical staff of the French teaching hospital where the study was performed, and patients scheduled for rhinomanometry (sleep apnea syndrome, planned check-ups). After clinical examination, candidates with a positive COVID-19 test in the preceding two months, symptoms suggestive of current COVID-19 (cough, fever, anosmia, etc.), other ongoing viral infection, septal perforation or complete nasal obstruction (disruption of rhinomanometry and acoustic rhinometry) were excluded from the study. Medical face masks meeting European standard EN 14683 were used.

#### Ethics

Formal ethics approval as per the Declaration of Helsinki was required and granted by a regional institutional review board (Agreement 2021-A02445-36). Informed consent was obtained from all study participants.

#### Data collection and clinical evaluation

All data were collected during a specialist otolaryngological examination performed on the day of inclusion. The patients also filled out a questionnaire to supply their personal and medical histories. General (age, gender, body mass index (BMI), ongoing treatments), daily exposure (current or former occupation, current or past smoking habits, number of hours per day spent wearing a mask) and rhinologic symptoms (hyposmia, chronic rhinitis, history of rhinologic surgery, cranio-facial trauma) data were collected. Participants benefited from an anterior nasal clinical examination including external inspection of the nose, dynamic evaluation of the internal nasal valve on forced inspiration, and anatomical study of the first five centimeters of the nasal cavity and cartilaginous septum using a nasal speculum. For each

volunteer, the presence of septal deviation or perforation, nasal valve syndrome, rhinitis or nasal polyps was noted.

#### Anterior rhinomanometry

As per recommendations <sup>1</sup>, anterior rhinomanometry was performed in a sitting position with a RHINO-SYS rhinomanometer (Happersberger Otopront, Langgasse, Hohenstein, Germany) calibrated daily. The nasal airflow measurements required that the device's face mask be fitted with a flow measuring device (a pneumotach connected to an electronic differential pressure transducer) to calculate right and left nasal fossa resistance. For uninasal anterior measurements, the contralateral nostril was occluded with surgical tape. As recommended in the Riga conference consensus <sup>3</sup>, the effective resistance of the entire breath (Reff) was estimated from the pressure flow curve recorded by anterior rhinomanometry. For clinical purposes the values were expressed as common logarithmic values (LReff = log (10\*Reff)).

$$Reff = \sqrt{\frac{\int_0^T \Delta P^2 dt}{\int_0^T \dot{V}^2 dt}}$$

#### Acoustic rhinometry

Acoustic rhinometry was performed using the two-microphone acoustic reflection method, enabling the measurement of minimal cross-sectional areas and, with external increasing negative pressure, nasal compliance as previously described <sup>2</sup>. Briefly, longitudinal area profiles of the nasal cavity, A(x), were determined for each patient by the above-mentioned method <sup>3,4</sup>. The following median minimal cross-sectional areas (MCA) and nasal volumes (Vol) were calculated: MCA-1 (0-20 mm from the nasal entrance), MCA-2 (20-50 mm from the nasal entrance), Vol 1 (0-20 mm from the nasal entrance), and Vol 2 (20-50 mm from the nasal entrance). The setup used was derived from a device provided by Benson Hood Laboratories (Pembroke, MA, USA) consisting of two microphones and a horn driver mounted on a homemade wave tube (inner diameter 12 mm, overall length 220 mm).

### Nasal compliance

Nasal compliance was estimated, as previously described<sup>5,6</sup>, from the measurements of  $A(x)$  when different steady pressures were applied to the distal end of the wave tube connected to the nostril. Compliance per unit length was defined as the ratio between the variation of area  $[\Delta A(x)]$  and the variation of steady pressure ( $\Delta P$ ) applied to the nasal cavity. To facilitate interpretation of compliances and areas, the nasal cavity was divided into three distinct physiological segments, as previously described: the valve segment (C1), the inferior turbinate segment (C2), and the middle meatus segment (C3)<sup>7</sup>.

Each volunteer was placed in a seated position and all rhinomanometry and acoustic rhinometry measurements were performed by experienced medical staff. The humidity of the room was measured by a digital hygrometer. The temperature at the entrance of the nasal cavity was measured by an external probe thermometer placed in front of the nasal entrance.

### Statistical analysis

The study deployed a within-subjects design wherein the test subjects acted as their own controls. Fifty participants were needed to show a statistical difference of 20% with 95% power (two-sided alpha risk of 5 %). The data analyzers were blinded to the masked/unmasked state of the volunteers. Statistical tests were performed using IBM SPSS Statistics, version 20. Continuous values were expressed as means  $\pm$  standard deviation (SD) and categorical values as numbers and percentages. The intra-group results with and without masks were compared using Student's t test (t test) and one-way analysis of variance (ANOVA). A p value  $<0.05$  was considered significant.

## **References**

1. Vogt K, Bachmann-Harildstad G, Lintermann A, Nechyporenko A, Peters F, Wernecke KD. The new agreement of the international RIGA consensus conference on nasal airway function tests. *Rhinology*. 2018;56(2):133-143. doi:10.4193/Rhin17.084
2. Brugel-Ribere L, Fodil R, Coste A, et al. Segmental analysis of nasal cavity compliance by acoustic rhinometry. *J Appl Physiol (1985)*. 2002;93(1):304-310. doi:10.1152/jappphysiol.00085.2002
3. Louis B, Fodil R, Jaber S, et al. Dual assessment of airway area profile and respiratory input impedance from a single transient wave. *J Appl Physiol (1985)*. 2001;90(2):630-637. doi:10.1152/jappphysiol.2001.90.2.630
4. Louis B, Glass G, Kresen B, Fredberg J. Airway area by acoustic reflection: the two-microphone method. *J Biomech Eng*. 1993;115(3):278-285. doi:10.1115/1.2895487
5. Fodil R, Brugel-Ribere L, Croce C, et al. Inspiratory flow in the nose: a model coupling flow and vasoerectile tissue distensibility. *J Appl Physiol (1985)*. 2005;98(1):288-295. doi:10.1152/jappphysiol.00625.2004
6. Kesavanathan J, Swift DL, Bascom R. Nasal pressure-volume relationships determined with acoustic rhinometry. *J Appl Physiol (1985)*. 1995;79(2):547-553. doi:10.1152/jappphysiol.1995.79.2.547
7. Papon JF, Brugel-Ribere L, Fodil R, et al. Nasal wall compliance in vasomotor rhinitis. *J Appl Physiol (1985)*. 2006;100(1):107-111. doi:10.1152/jappphysiol.00575.2005

**Supplementary table 1:** General and rhinologic characteristics of the patients (n=50).

*Legend : Continuous and categorical values expressed respectively as mean ( $\pm$  standard deviation (SD)) and number (percentage). No. = number. BMI = body mass index.*

**Supplementary figure 1:** Procedure of the study.

*Abbreviations : ENT= Ear Nose Throat.*

**Supplementary table 1:** General and rhinologic characteristics of the patients (n=50).

	<b>N = 50</b>
<b>Age, years</b>	30.8 ± 13.0
<b>Male, No. (%)</b>	15 (30)
<b>BMI, kg/m<sup>2</sup></b>	22.7 ± 4.2
<b>Tobacco use, pack years</b>	2 ± 5.3
<b>Atopy, No. (%)</b>	10 (20)
<b>Septal deviation, No. (%)</b>	20 (40)
<b>Hours wearing a mask/day</b>	6.9 ± 3.3

*Legend : Continuous and categorical values expressed respectively as mean ( $\pm$  standard deviation (SD)) and number (percentage). No. = number. BMI = body mass index.*

**Supplementary figure 2:** Geometry (MCA-1) at the valve segment of each nasal fossa in patients with a mask for thirty minutes (T1) compared to not wearing a mask for thirty minutes (T2) (n=50).

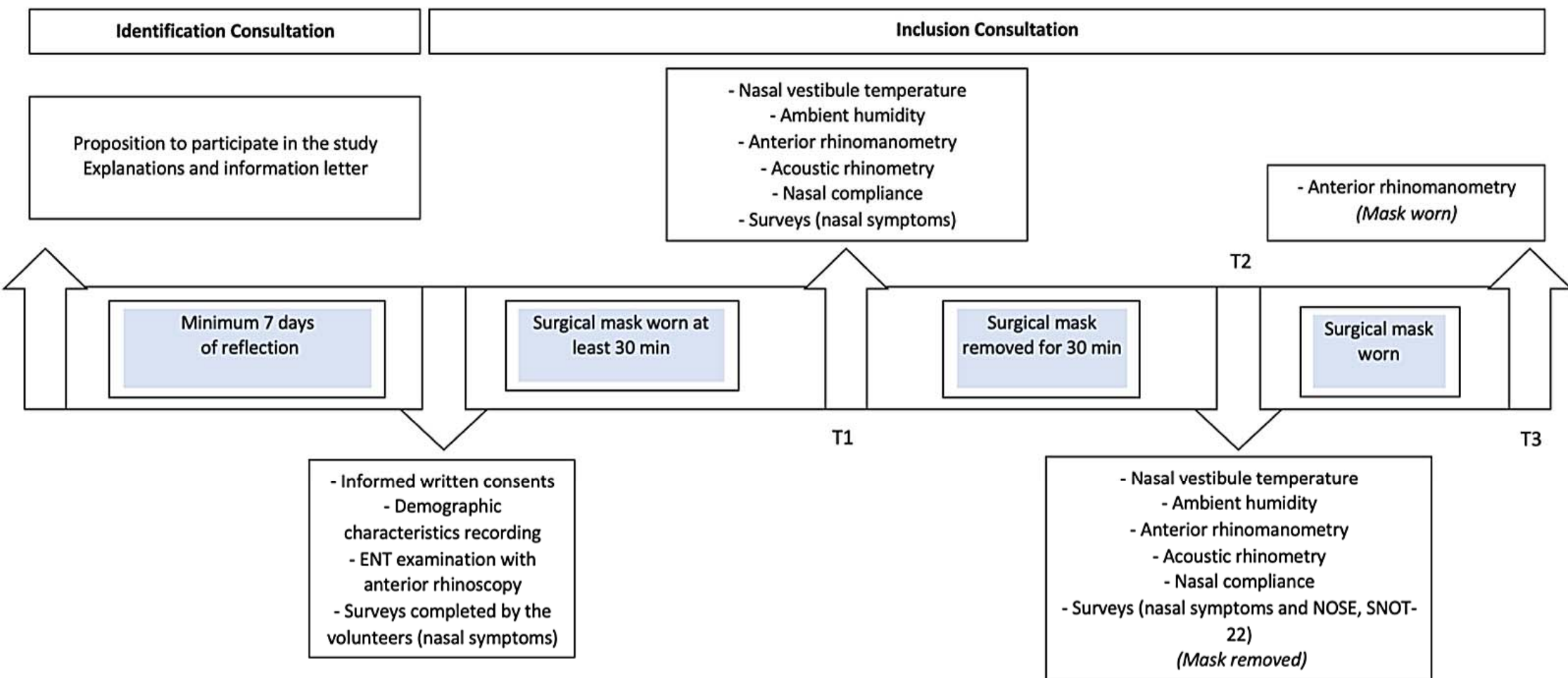
*Legend : Results plotted as mean  $\pm$  SE (error bars).*

*Abbreviations : MCA-1 = Minimal cross-sectionnal area 1 localized at the valve segment.*

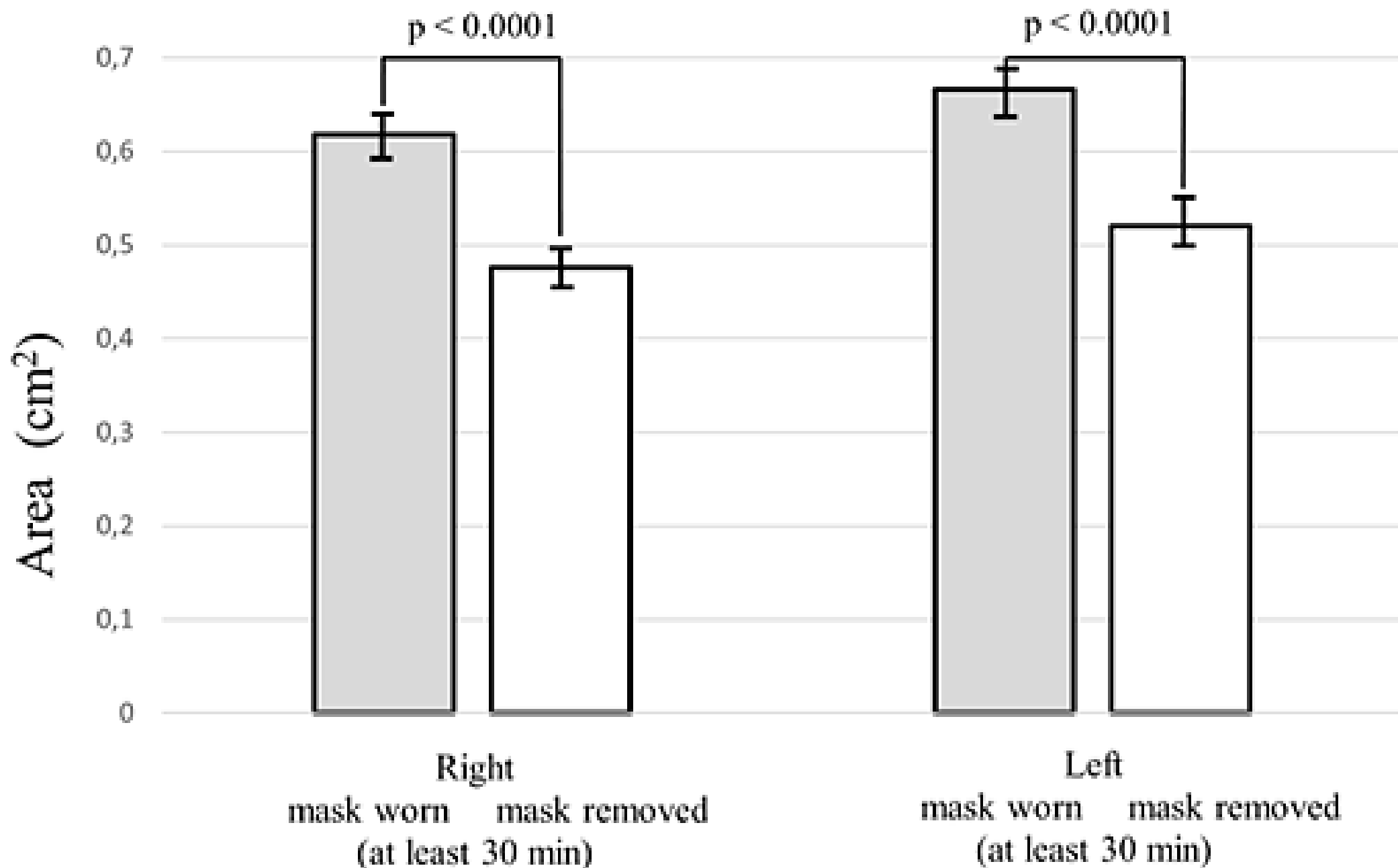


**Supplementary figure 3:** Compliance of the three nasal segments (valve, inferior turbinate, middle meatus) in patients with a mask for thirty minutes (T1) compared to not wearing a mask for thirty minutes (T2).

*Legend : Results plotted as mean  $\pm$  SE (error bars).*



## Acoustic Rhinometry (MCA-1)



*MCA-1 = Minimal cross-sectional area 1 localized at the valve segment*

# Compliance

