

## Scientific Letter

### Effects of a Surgical Mask on Functional Capacity Measured Using the 6-min Walk Test in Patients with Cardiorespiratory Disease



To the Director,

In March 2020, the World Health Organization (WHO) declared a state of pandemic due to the disease caused by the SARS-CoV-2 coronavirus, and health measures were established to curb the transmission of the virus, including the mandatory use of masks. The WHO recommendations state that the masks are not required in people with respiratory distress that could be aggravated by its use,<sup>1</sup> while the European Centre for Disease Prevention and Control (ECDC)<sup>2</sup> and the Spanish Society of Pulmonology and Thoracic Surgery (SEPAR) recommended its use in groups at risk of developing serious complications. Patients with cardiorespiratory diseases reported a worsening of their respiratory symptoms as a result of mask-wearing.

The 6-min walk test (6MWT) is a submaximal test used as a tool to evaluate functional capacity and as a prognostic factor and predictor of mortality.<sup>3–6</sup> The aim of our study was to determine the effect of a surgical mask on functional capacity, measured by 6MWT, in patients with cardiorespiratory disease.

We performed a prospective observational study that included 108 patients with cardiorespiratory disease, who were referred to our hospital for a 6MWT between September and November 2020. After signing an informed consent form, each patient performed 2 walk tests, 1 with and 1 without a surgical mask, with a 20-min recovery period between tests. The order of mask-wearing or not was determined by simple randomization. Patients who had been hospitalized within the previous 3 months or who presented chronic respiratory failure were excluded.

The 6MWT test was performed following ATS recommendations, and was used to measure the main study parameters<sup>7</sup>: distance walked (meters); peripheral oxygen saturation ( $\text{Sat}_p\text{O}_2$ ) and heart rate (HR) ( $\text{bpm}^{-1}$  at start, end, and after a 1-min recovery period (measured with pulse oximeter); blood pressure (BP) (mmHg), dyspnea, and leg fatigue (measured with the modified BORG scale<sup>8</sup>) were determined at the start and end of the test. Heart rate recovery rate (HRRR) was considered adequate when the difference between the final HR and the HR after a 1-minute recovery period was at least  $15 \text{ bpm}^{-1}$ .<sup>3</sup> Clinically significant desaturation was defined as a peripheral oxygen saturation value of less than 88% for at least 2 min and/or a decrease of 4% compared to the previous reading.<sup>3</sup> Anthropometric data, clinical history, and lung function parameters were collected prior to the 6MWT, following national and international recommendations.<sup>9</sup>

The statistical analysis was performed using SPSS Version 15.0 (IBM software). Quantitative variables were expressed as mean and standard deviation (media  $\pm$  SD), and qualitative variables were expressed as percentages. The comparison of means for paired

**Table 1**

Clinical characteristics, cardiological history, respiratory history, and treatments.

<i>Clinical characteristics</i>		
Age (years)	64 $\pm$ 12.8 (27–89)	
Sex	31 women (28.7%)/77 men (71.3%)	
BMI ( $\text{kg}/\text{m}^2$ )	27.4 $\pm$ 5 (14.4–47). BMI > 30: 30 (28%)	
Smokers (n %)	63 former smokers (58.3%)	
	17 smokers (15.7%)	
	Mean pack-years: 36.5 $\pm$ 18.4	
High BP (n %)	42 (38.9%)	
Diabetes (n %)	18 (16%)	
Dyslipidemia (n %)	30 (27.8%)	
<i>Cardiological comorbidities</i>		
Structural heart disease:	20 (18.5%):	Hypertrophic cardiomyopathy: 6 (5.6%) Ischemic heart disease 12 (11.1%) Valvular heart disease: 2 (1.9%)
Atrial fibrillation	11 (10.2%)	
<i>Respiratory comorbidities</i>		
Asthma	1 (0.9%)	
COPD	50 (46.3%)	Mild: 7.4% Moderate: 23.1% Severe: 9.3% Very severe: 6.5%
Emphysema	23 (21.3%)	
SAHS	7 (6.5%)	Severe SAHS 4.6%
Diffuse interstitial pulmonary disease	33 (30.6%)	IPF: 13.9% Pneumoconiosis: 4.6% Diffuse ILD + autoimmune disease: 3.7% Other: 8.4%
Bronchiectasis	6 (5.6%)	
Pulmonary hypertension	1 (0.9%)	
Other respiratory diseases	13 (12%)	
<i>Lung function tests</i>		
FEV1%	70.4 $\pm$ 24.3	
FVC%	78.8 $\pm$ 19.2	
FEV1/FVC	66.8 $\pm$ 14.6	
VR/TLC	47.1 $\pm$ 12.9	
DLCO (% predicted)	62.7 $\pm$ 19.2	

data (Student's *t* test) was used for quantitative variables and the Chi-squared test for qualitative variables. A *p*-value <0.05 was considered statistically significant.

A total of 108 patients, 77 men (71%), were included, with a mean age of 64  $\pm$  12.8 years (27–89). Sixty-three (58.3%) were former smokers and 17 (15.7%) were active smokers. Table 1 shows the clinical characteristics, cardiorespiratory comorbidities, and lung function test results of the cohort.

No statistically significant differences were found in baseline cardiorespiratory parameters (HR,  $\text{Sat}_p\text{O}_2$ , BP) before the 6MWT test was performed with and without the mask. Statistically significant differences were found in the distance walked (*p* = 0.006), and

**Table 2**  
Walk test parameters with and without surgical mask.

	Without mask	With mask	<i>p</i>
Distance walked (m)	483.45 ± 95.55	474.06 ± 96.14	0.006
Baseline SBP (mmHg)	131.15 ± 20.56	132.5 ± 19.55	0.223
Baseline DBP (mmHg)	77.73 ± 12.21	77.31 ± 12.37	0.556
Post-test SBP (mmHg)	136.4 ± 20.88	139.16 ± 22.42	0.020
Post-test DBP (mmHg)	78.44 ± 11.86	79.29 ± 13.48	0.383
Baseline HR (bpm <sup>-1</sup> )	78.77 ± 14.13	78.53 ± 13.95	0.712
Post-test HR (bpm <sup>-1</sup> )	114.74 ± 19.80	115.46 ± 22.13	0.593
HR after 1 min recovery <sup>a</sup> (bpm <sup>-1</sup> )	100.42 ± 18.91	100.05 ± 18.45	0.645
Low HRRR (%)	58%	62%	0.584
Baseline Sat <sub>p</sub> O <sub>2</sub> (%)	96.35 ± 2.06	96.38 ± 1.93	0.824
Post-test Sat <sub>p</sub> O <sub>2</sub> (%)	92.56 ± 4.72	92.08 ± 4.96	0.016
Mean Sat <sub>p</sub> O <sub>2</sub> (%)	93.35 ± 3.87	93.16 ± 3.78	0.196
Significant desaturation (%) <sup>b</sup>	16.7%	14.8%	0.709
Baseline dyspnea	0.38 ± 1.01	0.52 ± 1.12	0.211
Post-test dyspnea	2.90 ± 2.03	3.91 ± 4.36	0.040
Baseline leg fatigue	0.31 ± 0.93	0.43 ± 1.22	0.239
Post-test leg fatigue	1.75 ± 2.29	1.70 ± 2.15	0.690

DBP: diastolic blood pressure; HR: heart rate; HRRR: heart rate recovery rate; SBP: systolic blood pressure.

<sup>a</sup> Low HRRR: difference between end-of-test HR and recovery HR < 15 bpm.

<sup>b</sup> Significant desaturation: Sat<sub>p</sub>O<sub>2</sub> < 88% for at least 2 min.

post-test systolic blood pressure ( $p = 0.020$ ), Sat<sub>p</sub>O<sub>2</sub> ( $p = 0.016$ ), and dyspnea ( $p = 0.040$ ). 6MWT results are summarized in Table 2.

Some patients with chronic heart and respiratory diseases have associated the use of the mask for protection against viral infection with an increase in dyspnea during physical exercise. In our study, in which we performed the 6MWT in the same patient with and without a mask, we observed a shorter distance walked, lower blood oxygen, higher systolic BP, and a greater subjective perception of dyspnea in mask wearers at the end of the test. Other studies conducted in healthy volunteers, such as the study by Cabanillas et al.,<sup>10</sup> and Person et al.,<sup>11</sup> found no differences in 6MWT parameters, whereas the study conducted by Kyung et al.<sup>12</sup> that included 97 COPD patients showed similar results to ours.

A difference of 54 meters (95% CI: 37–71 m) in the distance walked is generally thought to be the threshold at which a patient perceives a change in functional capacity,<sup>13</sup> although some studies in COPD, ILD, and pulmonary arterial hypertension specify a mean of 30 m (25–33 m) as the minimum change that would have clinical significance.<sup>3</sup> In our study, the difference in distance walked was statistically significant, but still below the clinically relevant threshold.

Samannan et al.<sup>14</sup> sought to determine the effect of the mask on gas exchange in 15 healthy patients and 15 severe COPD patients who underwent a 6MWT. They measured Sat<sub>p</sub>O<sub>2</sub> and pCO<sub>2</sub> before and immediately after the test, and found no differences in either group. In contrast, Kyung et al.<sup>12</sup> observed an increase in the breathing rate and exhaled carbon dioxide levels, and a decrease in Sat<sub>p</sub>O<sub>2</sub> with the use of the N95 mask. In our study, we found a difference of 0.5% in Sat<sub>p</sub>O<sub>2</sub> at the end of the 6MWT that was statistically significant ( $p = 0.016$ ) but probably lacking in clinical relevance.

Finally, most of the studies analyzed found a change in the subjective sensation of dyspnea. The use of the mask probably involves an increase in inspiratory and expiratory pressures, resulting in forced and superficial breathing and increased activation of the accessory muscles.<sup>15</sup> Moreover, the increase in thermosensitive afferent impulses and the humidity of the inspired air causes bronchoconstriction and increases pulmonary resistance. All these factors, together with certain psychological phenomena, such as anxiety or claustrophobia,<sup>16</sup> may be responsible for this subjective feeling of discomfort associated with the use of a mask. We assessed the subjective feeling of dyspnea in our study by using the modified Borg scale<sup>17,18</sup>: significant differences were found between the

pre- and post-test values. Person et al.<sup>11</sup> and Cabanillas et al.,<sup>10</sup> using a visual analogue scale (VAS), found a significant increase in dyspnea in the test performed with the mask (1 cm on VAS).<sup>17</sup>

The limitations of our study are its single-center design and the use of a single type of mask (surgical). However, it was conducted in patients with cardiorespiratory disease, which adds value to the results.

In conclusion, the use of a surgical mask has been a health measure that has played a key role in the control of the pandemic and is likely to be maintained over time to prevent the transmission of other respiratory diseases. The use of a surgical mask by patients with cardiac or respiratory disease does not alter the functional capacity measured by the 6MWT, but it does increase the subjective sensation of dyspnea.

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