Archivos de Bronconeumología 58 (2022) 675–677

Sociedad Española de Neumología y Cirugía Torácica SEPAR

ARCHIVOS DE Bronconeumología

www.archbronconeumol.org

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,[1] while the European Centre for Disease Prevention and Control (ECDC)[2] 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.[3–6] 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[7]: distance walked (meters); peripheral oxygen saturation ($Sat_pO_2$) and heart rate (HR) ($bpm^{-1}$ 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[8]) 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 $bpm^{-1}$.[3] 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.[3] Anthropometric data, clinical history, and lung function parameters were collected prior to the 6MWT, following national and international recommendations.[9]

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

**Table 1**
Clinical characteristics, cardiological history, respiratory history, and treatments.

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

A total of 108 patients, 77 men (71%), were included, with a mean age of 64 ± 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, $Sat_pO_2$, 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

https://doi.org/10.1016/j.arbres.2022.06.004

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

| | Without mask | With mask | p |
|---|---|---|---|
| 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 ($bpm^{-1}$) | 78.77 ± 14.13 | 78.53 ± 13.95 | 0.712 |
| Post-test HR ($bpm^{-1}$) | 114.74 ± 19.80 | 115.46 ± 22.13 | 0.593 |
| HR after 1 min recovery[a] ($bpm^{-1}$) | 100.42 ± 18.91 | 100.05 ± 18.45 | 0.645 |
| Low HRRR (%) | 58% | 62% | 0.584 |
| Baseline $Sat_pO_2$ (%) | 96.35 ± 2.06 | 96.38 ± 1.93 | 0.824 |
| Post-test $Sat_pO_2$ (%) | 92.56 ± 4.72 | 92.08 ± 4.96 | 0.016 |
| Mean $Sat_pO_2$ (%) | 93.35 ± 3.87 | 93.16 ± 3.78 | 0.196 |
| Significant desaturation (%)[b] | 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.
[a] Low HRRR: difference between end-of-test HR and recovery HR < 15 bpm.
[b] Significant desaturation: $Sat_pO_2$ < 88% for at least 2 min.

post-test systolic blood pressure ($p = 0.020$), $Sat_pO_2$ ($p = 0.016$), 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.,[10] and Person et al.,[11] found no differences in 6MWT parameters, whereas the study conducted by Kyung et al.[12] 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,[13] 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.[3] In our study, the difference in distance walked was statistically significant, but still below the clinically relevant threshold.

Samannan et al.[14] 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 $Sat_pO_2$ and $pCO_2$ before and immediately after the test, and found no differences in either group. In contrast, Kyung et al.[12] observed an increase in the breathing rate and exhaled carbon dioxide levels, and a decrease in $Sat_pO_2$ with the use of the N95 mask. In our study, we found a difference of 0.5% in $Sat_pO_2$ 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.[15] 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,[16] 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[17,18]: significant differences were found between the pre- and post-test values. Person et al.[11] and Cabanillas et al.,[10] using a visual analogue scale (VAS), found a significant increase in dyspnea in the test performed with the mask (1 cm on VAS).[17]

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.

## References


1. World Health Organization. Mask use in the context of COVID-19. In: Interim guidance; 2020 https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak [accessed March 2021].
2. Guidelines for non-pharmaceutical interventions to reduce the impact of COVID-19 in the EU/EEA and the UK. 24 September 2020. Stockholm: ECDC; 2020 https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-guidelines-non-pharmaceutical-interventions-september-2020.pdf [accessed March 2021].
3. Singh SJ, Puhan MA, Andrianopoulos V, Hernandes NA, Mitchell KE, Hill CJ, et al. An official systematic review of the European Respiratory Society/American Thoracic Society: measurement properties of field walking tests in chronic respiratory disease. Eur Respir J. 2014;44:1447–78, http://dx.doi.org/10.1183/09031936.00150414.
4. Lederer DJ, Arcasoy SM, Wilt JS, D'Ovidio F, Sonett JR, Kawut SM, et al. Six-minute walk distance predicts waiting list survival in idiopathic pulmonary fibrosis. Am J Respir Crit Care Med. 2006;174:659–64, http://dx.doi.org/10.1164/rccm.200604-520OC.
5. Casanova C, Cote C, Marín JM, Pinto-Plata V, de Torres JP, Aguirre-Jaíme A, et al. Distance and oxygen desaturation during the 6-min walk test as predictors of long-term mortality in patients with COPD. Chest. 2008;134:746–52, http://dx.doi.org/10.1378/chest.08-0520.
6. Karanth MS, Awad NT. Six minute walk test: a tool for predicting mortality in chronic pulmonary diseases. J Clin Diagn Res. 2017;11:34–8, http://dx.doi.org/10.4081/monaldi.2020.1186.
7. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, American Thoracic Society. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166:111–7, http://dx.doi.org/10.1164/ajrccm.166.1.at1102.
8. Borg.F G. Psychophysical bases of perceived exertion. J Med Sci Sports Exercise. 1982;14:377–81.
9. Garcia-Rio F, Calle M, Burgos F, Casan P, Del CF, Galdiz JB, et al. Spirometry. Spanish Society of Pulmonology and Thoracic Surgery (SEPAR). Arch Bronconeumol. 2013;49:388–401, http://dx.doi.org/10.1016/j.arbres.2013.04.001.
10. Cabanillas-Barea S, Rodríguez-Sanz J, Carrasco-Uribarren A, López-de-Celis C, González-Rueda V, Zegarra-Chávez D, et al. Effects of using the surgical mask and FFP2 during the 6-min walking test. A randomized controlled trial. Int J Environ Res Public Health. 2021;18:12420, http://dx.doi.org/10.3390/ijerph182312420.
11. Person E, Lemercier C, Royer A, Reychler G. Effect of a surgical mask on six-minute walking distance. Rev Mal Respir. 2018;35:264–8, http://dx.doi.org/10.1016/j.rmr.2017.01.010.
12. Kyung SY, Kim Y, Hwang H, Park JW, Jeong SH. Risks of N95 face mask use in subjects with COPD. Respir Care. 2020;65:658–64, http://dx.doi.org/10.4187/respcare.06713.
13. Redelmeier DA, Bayoumi AM, Goldstein RS, Guyatt GH. Interpreting small differences in functional status: the six-minute walk test in chronic lung disease patients. Am J Respir Crit Care Med. 1997;155:1278–82, http://dx.doi.org/10.1164/ajrccm.155.4.9105067.
14. Samannan R, Holt G, Calderon-Candelario R, Mirsaeidi M, Campos M. Effect of face mask on gas exchange in healthy persons and patients with COPS. Ann Am Thorac Soc. 2021;18:541–4, http://dx.doi.org/10.1513/AnnalsATS. 202007-812RL.
15. Sinkule EJ, Powell JB, Goss FL. Evaluation of N95 respirator use with a surgical mask cover: effects on breathing resistance and inhaled carbon dioxide. Ann Occup Hyg. 2013;57:384–98, http://dx.doi.org/10.1093/annhyg/mes068.
16. Roberge RJ, Kim JH, Benson SM. Absence of consequential changes in physiological, thermal and subjective responses from wearing a surgical mask. Respir Physiol Neurobiol. 2012;181:29–35, http://dx.doi.org/10.1016/j.resp.2012.01.010.
17. Ries AL. Minimally clinically important difference for the UCSD. Shortness of Breath Questionnaire, Borg Scale, and Visual Analog Scale. COPD. 2005;2:105–10, http://dx.doi.org/10.1081/COPD-200050655.

18. Mador MJ, Rodis A, Magalang UJ. Reproducibility of Borg scale measurements of dyspnea during exercise in patients with COPD. Chest. 1995;107:1590–7, http://dx.doi.org/10.1378/chest.107.6.1590.

Covadonga de la Escosura Muñoz [a], Marta Iscar Urrutia [b,*], Marina de la Escosura Muñoz [c], Ramón Fernández Álvarez [b], Gemma Rubinos Cuadrado [b], Cristina Hernández González [a], Marta María García Clemente [b]

[a] *Área de Gestión Clínica del Pulmón, Spain*
[b] *Área de Gestión Clínica del Pulmón. Instituto de investigación sanitaria del Principado de Asturias (ISPA), Spain*
[c] *Servicio de Neumología del Hospital Universitario de Navarra, Spain*

Corresponding author.
*E-mail address:* martaiscar@gmail.com (M.I. Urrutia).