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Are the Treadmill Test Results Reliable in Terms of Diagnosis when Performed Using a Surgical Mask?

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Abstract

Objectives: Mask use plays a substantial role in reducing the spread of coronavirus disease-2019 in confined spaces. However, the use of masks is controversial in cases where intense effort is required, such as in the treadmill exercise test. In this study, the diagnostic reliability of the treadmill exercise test performed using a mask was questioned.

Materials and Methods: Two groups (with and without mask) were compared concerning various characteristics to assess diagnostic reliability and safety.

Results: The diagnostic reliability test performed using a mask was found to be similar to that of tests performed without a mask.

Conclusion: The treadmill exercise test performed by wearing surgical masks results is reliable for diagnosis.

Keywords: COVID-19, exercise treadmill testing, masks, sport

Introduction

The World Health Organization (WHO) declared coronavirus disease-2019 (COVID-19) as a pandemic on March 11, 2020, which was coincidentally also the date on which the first confirmed COVID-19 case was reported in Turkey[1,2]. Since this new type of Severe Acute Respiratory Syndrome virus is transmitted by droplets, the importance of covering the mouth/nose with masks was emphasized[2-4]. Using a mask while exercising, particularly during intense exercise, may cause some problems and WHO currently recommends that a mask should not be worn while exercising[5]. However, there are situations where exercise is necessary even during the pandemic period, such as in the treadmill exercise test.

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In young individuals and athletes, various studies have shown that it is quite safe to exercise while wearing surgical masks covering the mouth and nose. However, this issue is still controversial, especially in subjects with advanced age-who represent most population in whom the treadmill exercise test is performed[6,7]. The safety of exercise has not been confirmed in this patient group when masks are used. The predicted risks include carbon dioxide retention and slight reduction in oxygen saturation with intense exercise[8].

This study was therefore conducted to answer this question: Are effort tests in patients wearing masks reliable in terms of the accuracy of test results?

Materials and Methods

The study was approved by the Eskişehir Osmangazi University Non-Interventional Clinical Research Ethics Committee Presidency (approval number: 2020-441, date: 03.11.2020).

Study Design and Subjects

Patients older than 18 years who were admitted to the cardiology outpatient clinic of a tertiary healthcare institution between February 2020 and March 2020 and were scheduled for a treadmill exercise test due to a suspicion of ischemic heart disease were enrolled in the study consecutively. All patients who underwent a treadmill exercise test during this period were included in the study. Patients whose complaints were not recorded in the outpatient files after the effort test, and those with artefacts that prevented the accurate evaluation of the treadmill exercise test were excluded from the study. Since the first cases of confirmed COVID-19 were seen in our country (Turkey) on March 11, 2020, it was decided by the cardiology department of our hospital that both the patient and the healthcare professionals who performed the test would use a surgical mask while treadmill exercise tests were performed. As of this date, all 169 patients who underwent the treadmill exercise test and healthcare professionals who performed the test used surgical masks throughout the procedure. In the tests conducted before this date, no masks were used.

The patients were divided into two groups concerning mask wearing. The complaints and complications of the patients during the effort test and their test results were examined, and the two groups were compared in terms of clinical characteristics. The demographic information, chronic diseases and complaints of the patients during the effort test were taken from the digital database of the hospital and clinical files. Additionally, coronary angiography data of patients who underwent the procedure due to having a positive effort test result was obtained from patients' file records.

Treadmill Exercise Test

Patients were informed not to eat and smoke for at least three hours before the examination, and they were instructed to stop any drug that would affect the test result, such as beta blockers, calcium channel blockers, digoxin, s anti-arrhythmic drugs and nitrate, for at least three days before the examination. Treadmill exercise testing was performed in a regular fashion in the routine laboratory; all tests were supervised by a trained member of the healthcare staff. Heart rate and blood pressure were monitored throughout the exercise and patient was monitored for any symptoms, such as chest pain, shortness of breath, fatigue, dizziness or nausea. We applied the Bruce protocol for treadmill exercise test. Duke Treadmill Score (DTS) was performed to assist the risk assessment of patients who had undergone a treadmill exercise test. Scores may vary from +15 to -25. A score ≥5 means low risk, while a score less than or equal to 11 means high risk[9]. Patients with a low-risk estimation were referred for additional risk stratification with imaging methods. Chest pain that developed during the exercise test was classified with the Diamont chest pain classification[10].

Coronary Angiography

Coronary angiography was performed in patients with moderate and high DTS risk if the suspicion of coronary artery disease persisted clinically. The patients

were divided into 3 groups according to the coronary angiography results. Lesions that would cause more than 50% stenosis in the LMCA in coronary arteries of 2 mm or greater, or more than 70% in other vessels, were defined as having critical stenosis of the coronary artery. Those with relatively less-severe lesions with slow coronary flow were considered to have non-critical coronary artery stenosis. Finally, those with no lesions or plaques were considered to have normal coronary arteries. Patients with a positive effort test and those with critical and non-critical coronary stenosis were considered to have coronary artery disease.

Statistical Analysis

All analyses were performed on SPSS v21 (SPSS Inc., Chicago, IL, USA). Histograms and Q-Q plots were used to determine whether variables were normally distributed. Data are given as mean ± standard deviation or median (minimum-maximum) for continuous variables according to the normality of distribution, and as frequency (percentage) for categorical variables. Normally distributed variables were analyzed with the independent samples t-test. Non-normally distributed variables were analyzed with the Mann-Whitney U test. Categorical distributions were analyzed chi-square tests, including the Fisher's exact test when necessary. The between-group comparisons of the diagnostic performance of the treadmill effort test were performed using the two-proportions Z-test. Two-tailed p-values of less than 0.05 were considered statistically significant.

Results

We included 314 patients (128 females and 186 males) into our study, mean age was 48.67±12.66 (range 18-82) years. There were no significant differences between the groups concerning age, gender, height, weight, body mass index, smoking, alcohol usage, comorbidities and ejection fraction (Table 1).

One hundred and sixty-three (96.45%) patients reached the target heart rate in the mask-wearing group and 139 (95.86%) patients reached the target heart rate in the non-mask group (p=1.000). There were no significant differences between the groups concerning stage, MET, time, systolic blood pressure and diastolic blood pressures (Table 2).

Table 1. Summary of patients characteristics with regard to groups

	Mask during test		
	Present (n=169)	**Absent (n=145)**	**p-value**
Age	49.11±13.13	48.14±12.11	0.500
Gender			
Female	67 (39.64%)	61 (42.07%)	0.663
Male	102 (60.36%)	84 (57.93%)	
Height	167.29±8.87	166.79±9.17	0.622
Weight	77.60±12.10	75.66±12.01	0.157
Body mass index	27.75±4.07	27.22±3.96	0.241
Smoking status	71 (42.01%)	68 (46.90%)	0.385
Alcohol usage	21 (12.43%)	17 (11.72%)	0.849
Hypertension	66 (39.05%)	50 (34.48%)	0.403
Diabetes mellitus	15 (8.88%)	9 (6.21%)	0.500
Coronary artery disease	24 (14.20%)	20 (13.79%)	1.000
Cerebrovascular disease	2 (1.18%)	3 (2.07%)	0.665
Ejection fraction	60 (55-66)	60 (55-66)	0.351

Data are given as mean ± standard deviation or median (minimum-maximum) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables

Thirty-eight patients underwent coronary angiography in the mask-wearing group, 22 (57.89%) patients had normal results, 8 (21.05%) patients were defined to have non-critical stenosis and 8 (21.05%) patients had critical stenosis. In the non-mask group, 31 patients underwent coronary angiography, which revealed that 19 (61.29%) patients had normal results, 3 (9.68%) patients had non-critical and 9 (29.03%) patients had critical stenosis (p=0.395). The positive predictive value of the treadmill exercise test was 42.11% [95% confidence interval (CI): 26.41% -57.80%] in the mask-wearing group, while it was 38.71% (95% CI: 21.56% -55.86%) in the non-mask group (p=0.775). The false positive rate was 14.38% (95% CI: 8.82% -19.94%) in the mask-wearing group and 14.29% (95% CI: 8.34% - 20.23%) in the non-mask group (Table 2).

Concerning symptoms during the test, we found that 59 (34.91%) patients in the mask-wearing group and 31

Table 2. Summary of the treadmill stress test and coronary angiography results and treadmill stress test performance according to coronary angiography results

	Mask during test		
	Present (n=169)	**Absent (n=145)**	**p-value**
Target heart rate			
Not reached	6 (3.55%)	6 (4.14%)	1.000
Reached	163 (96.45%)	139 (95.86%)	
Stage			
2	21 (12.43%)	15 (10.34%)	0.683
3	58 (34.32%)	56 (38.62%)	
4	55 (32.54%)	50 (34.48%)	
5	35 (20.71%)	24 (16.55%)	
Treadmill stress test results			
Not evaluated	2 (1.18%)	2 (1.38%)	0.966
Negative	128 (75.74%)	110 (75.86%)	
Low risk	1 (0.59%)	2 (1.38%)	
Medium risk	27 (15.98%)	22 (15.17%)	
High risk	11 (6.51%)	9 (6.21%)	
MET	13.4 (4.8-16.9)	13.4 (4.8-16.9)	0.712
Time	9.10±2.16	9.39±2.13	0.240
Systolic blood pressure (i)	129.08±13.27	128.11±13.34	0.519
Diastolic blood pressure (i)	78.85±8.61	78.89±8.77	0.965
Systolic blood pressure (f)	156.04±21.72	152.27±19.99	0.113
Diastolic blood pressure (f)	88.62±11.88	87.28±11.48	0.310
Coronary angiography			
Normal	22 (57.89%)	19 (61.29%)	0.395
Non-critical	8 (21.05%)	3 (9.68%)	
Critical	8 (21.05%)	9 (29.03%)	
Treadmill stress test performance			
Positive predictive value	42.11%	38.71%	0.775
False positive rate	14.38%	14.29%	0.982

Data are given as mean ± standard deviation or median (minimum-maximum) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables

(21.38%) patients in the non-mask group had shortness of breath during the treadmill exercise test, indicating a significant difference between the groups in this respect (p=0.008). However, there were no significant differences between the groups concerning the presence of dizziness, nausea, syncope and chest pain during the test (Table 3).

Supraventricular tachycardia, ventricular tachycardia and bradyarrhythmia were not observed in either group during exercise or recovery phases. Three patients aged 82 years old who underwent a treadmill exercise test with a mask did not have syncope, shortness of breath, dizziness and chest pain to end the test. In the mask-wearing group, there were 68 patients who ran more than 14 mets and the test was completed safely (Figures 1-3).

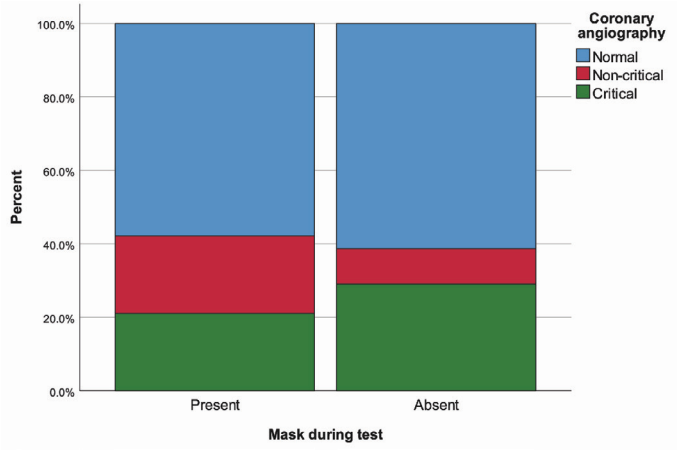

Figure 1. Coronary angiography results

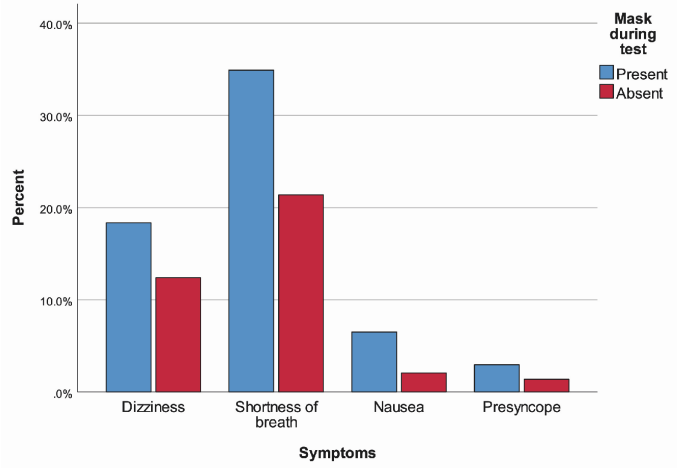

Figure 2. Symptoms during the treadmill stress test

Discussion

This study showed that the treadmill exercise test performed results with a surgical mask are reliable in the evaluation of ischemic heart disease compared with non-mask treadmill exercise tests, as demonstrated by similar outcomes in diagnostic results. Although we observed that the mask-wearing group had significantly higher frequency of shortness of breath, and some insignificant but appreciable increases in other symptoms, it appears that performing the treadmill exercise test with a mask remains a viable option because of similar safety and reliability with the usual, non-mask test. However, since the number of patients included in the study was small, it was not correct to conclude about the safety of performing the treadmill effort test with a mask.

Although there are reports in the media about deaths after intense exercise with masks[11], studies conducted on young athletes discussing the effects and safety of exercising with masks have not reproduced such findings[6,7]. Due to the lack of evidence about the reliability of the treadmill exercise test performed using a mask, the guidelines published by the Cardiovascular Imaging Council of the American College of Cardiology suggested that stress tests should be performed via pharmacological means if possible; however, if impossible, patients may undergo the effort test while wearing a mask[12]. In nuclear medicine practices, it is recommended to avoid effort testing and

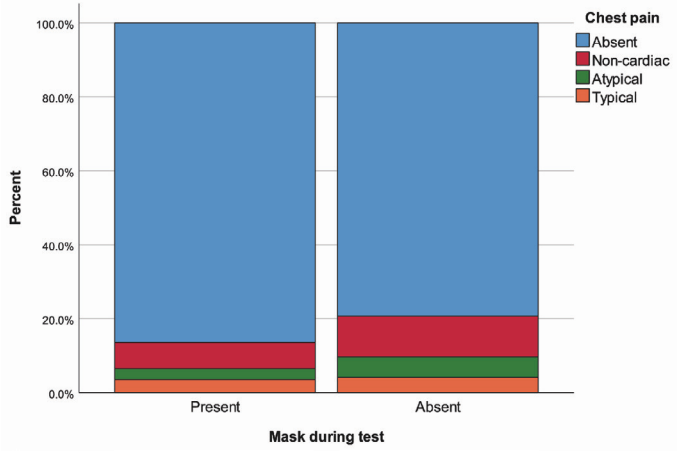

Figure 3. Chest pain during the treadmill stress test

Table 3. Summary of symptoms during the treadmill stress test

	Mask during test		
	Present (n=169)	**Absent (n=145)**	**p-value**
Dizziness	31 (18.34%)	18 (12.41%)	0.198
Shortness of breath	59 (34.91%)	31 (21.38%)	0.008
Nausea	11 (6.51%)	3 (2.07%)	0.104
Syncope			
Presyncope	5 (2.96%)	2 (1.38%)	0.458
Syncope	0 (0.00%)	0 (0.00%)	
Chest pain			
Non-cardiac	12 (7.10%)	16 (11.03%)	0.372
Atypical	5 (2.96%)	8 (5.52%)	
Typical	6 (3.55%)	6 (4.14%)	

Data are given as frequency (percentage) for categorical variables

to use protective equipment if it is necessary[13]. In this study, it was observed that mask-wearing individuals had no major differences from non-mask individuals in terms of the results, test-related symptoms.

The use of masks may cause various complaints, such as headache, fatigue, difficulty in concentration, decreased exercise tolerance, nausea, and increased heart rate[14,15]. In our study, it was found that the shortness of breath was more common in those that underwent the test while wearing masks. The shortness of breath was not severe enough to end the test, and all individuals with shortness of breath could continue the test until the target heart rate and MET value were reached or the test was completed. Non-cardiac chest pain was not severe and the two groups were again similar. The pain felt by patients after the treadmill test was almost always identified as muscle ache. Even if not statistically significant, dizziness and nausea were seen a little more in mask-wearing individuals compared to the non-mask group. We thought this situation might result from carbon dioxide retention and the possibility that increased moisture in the mask (due to sweating and strong inspiration).

One of the most important concerns with the treadmill exercise test is the possible problems in the reliability of the test. Using a mask during a short workout at an intensity of 6-8 METS reduces SO_2 by 3.7% and increases the CO_2 concentration by 20%. CO_2 increases to a greater degree in some mask models during exercise, and this may be uncomfortable and symptomatic for some subjects[16]. These symptoms may be mistakenly considered angina or dyspnea equivalent to angina and could cause erroneous DTS characterization. The treadmill exercise test is based on the principle of vasodilatation of coronary vessels and insufficient blood supply to ischemic vessels. Therefore, naturally, another question at this point arises does this clinically insignificant hypoxia and hypercarbia affect the test result? In our study, coronary artery disease was detected in only 12 of 31 patients in the non-mask, and 16 of the 38 patients in the mask-wearing group. There was no significant difference between the two groups in terms of the accuracy of the effort test in correctly detecting ischemia. This led us to the conclusion that the reliability of the stress test did not change with the use of a mask.

Study Limitations

Our study had some limitations. Since the study was retrospective, the researchers could not question whether the symptoms occurring during the test were directly associated with mask use or not. Since the number of patients included in the study was not enough, it does not give us certain information about the safety of treadmill effort, although it gives us some ideas about exercising with a mask[17].

Significant findings have shown that all patient groups can continue these activities by using masks in places such as physical therapy centers and gyms. Since there is evidence that cloth masks also reduce virus spread[18-20], the risk of COVID transmission can be reduced using a cloth mask in patients who cannot tolerate the surgical mask.

Conclusion

With this study, it has been shown that the treadmill exercise test results are reliable in patients wearing a mask.

Ethics

Ethics Committee Approval: The study was approved by the Eskişehir Osmangazi University Non-Interventional Clinical Research Ethics Committee Presidency (approval number: 2020-441, date: 03.11.2020).

Informed Consent: Since this is a retrospective study, informed consent was not obtained from the patients.

Peer-review: Externally peer-reviewed.

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