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Effect of Using Oxygen Concentrators on Oxygen Saturation after COVID-19 Infection

COVID-19 Enfeksiyonu Sonrası Oksijen Konsantratörü Kullanımının Oksijen Satürasyonu Üzerine Etkisi

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Abstract

Aim: The study was planned to evaluate the effect of oxygen concentrator use on oxygen saturations after COVID-19 infection.

Material and Method: The study included 42 patients who used oxygen concentrators and 66 patients who did not use concentrators and applied to Ankara Training and Research Hospital Pulmonology Outpatient Clinic between January 1, and April 8, 2021 after COVID-19 infection. Patients received a sociodemographic data questionnaire and a COVID-19 infection severity questionnaire, which were completed through face-to-face interviews. Patients' oxygen saturation levels were also measured and recorded at the time of interview.

Results: Those using oxygen concentrators were older and had less education (p=0.001; p=0.03, respectively). Patients who complained of shortness of breath during infection were mostly in the oxygen concentrator group, while those who had headaches and diarrhoea were mostly in the group that did not require concentrators. The group using oxygen concentrators had longer hospital stays due to COVID-19 infection (p=0.001). Patients using oxygen concentrators had higher rates of pulmonary involvement and lower oxygen saturation levels (p=0.001).

Conclusion: Patients who complained of dyspnea at the time of their COVID-19 diagnosis were more likely to require a concentrator at a later stage. Other factors influencing the need for concentrators include advanced age and education level. Patients using an oxygen concentrator had lower oxygen saturation levels, but the mean value was higher.

Keywords: COVID-19, hypoxia, oxygen therapy

Öz

Amaç: Çalışma, COVID-19 enfeksiyonu sonrası oksijen konsantaratörü kullanımının oksijen satürasyonlarına etkisini değerlendirmek için planlanmıştır.

Gereç ve Yöntem: Ankara Eğitim ve Araştırma Hastanesi Göğüs Hastalıkları polikliniğine 01.01.2021-08.04.2021 tarihleri arasında COVID-19 enfeksiyonu sonrasında başvuran, oksijen konsantratörü kullanan 42 hasta ile konsantratör kullanmayan 66 hasta çalışmaya dahil edildi. Katılımcılara; sosyodemografik veri formu ile COVID-19 enfeksiyonu şiddetini belirlemeyi amaçlayan sorulardan oluşan anket formu yüz yüze uygulandı ve hastaların o anki oksijen satürasyonları ölçülerek kaydedildi.

Bulgular: Oksijen konsantratörü kullananların ileri yaşta ve eğitim seviyesinin düşük olduğu görüldü (sırasıyla p=0.001; p=0.03). Enfeksiyon döneminde nefes darlığı şikayeti olan hastaların daha çok oksijen konsantratörü kullanan grupta olduğu; baş ağrısı ve ishal semptomları yaşayan hastaların ise konsantratör ihtiyacı olmayan grupta istatistiksel anlamlı olarak daha çok olduğu görüldü. COVID-19 enfeksiyonuna bağlı hastanede yatış süresi oksijen konsantratörü kullanan grupta daha yüksek bulundu (p=0.001). Oksijen konsantratörü kullanan hastalarda akciğer tutulumunun daha fazla ve oksijen satürasyonlarının daha düşük olduğu görüldü (p=0.001).

Sonuç: Çalışmamızda oksijen konsantratörü kullanan hastaların hastanede yatış süresi ve akciğer tutulumu daha fazlaydı. COVID-19 tanısı sırasında nefes darlığı şikayeti olan hastaların ilerleyen süreçte konsantratöre daha çok ihtiyaç duyduğu görüldü. İleri yaş ve eğitim seviyesi de konsantratör ihtiyacını etkilemekteydi.

Anahtar Kelimeler: COVID-19, hipoksi, terapi

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INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first identified in Wuhan, China, in December 2019. It quickly spread worldwide and evolved into a pandemic.[1-3] The leading cause of infection-related morbidity and mortality is viral pneumonia, which causes acute respiratory distress syndrome.[4] Progressive hypoxia due to lung damage and multiple organ dysfunctions are the main causes of mortality in critically ill COVID-19 patients.[5] The infection has a broad clinical severity spectrum; most patients have significant arterial hypoxemia but no symptoms of associated respiratory distress at hospital presentation. Some patients may not even feel short of breath, which is known as silent or 'happy' hypoxemia.[6]

Concerns have arisen regarding lung damage caused by COVID-19 infection in recovered patients. Follow-up chest CT scans of patients discharged after COVID-19 pneumonia have revealed persistent lung abnormalities, including ground-glass opacity.[7]

Patients with severe COVID-19 infection may develop chronic hypoxemic respiratory failure because of lung damage.[8] In patients hospitalised for COVID-19, the decrease in the diffusing capacity for carbon monoxide (DLCO) was found to be 52% at 4 months after discharge and 29% at 6 months after discharge.[9-11] Although studies have shown decreasing radiographic abnormalities and increasing DLCO after COVID-19 pneumonia over time, more research is needed for the small number of patients who have persistent lung dysfunction and hypoxemia. Long-term oxygen therapy (LTOT) is usually required for chronic obstructive pulmonary disease, idiopathic pulmonary fibrosis and pulmonary vascular disease.[12-15] During the COVID-19 pandemic, patients in need of oxygen therapy were discharged on LTOT in order to reduce the length of hospital stays and overcrowding in hospitals.

This study aimed to examine the long-term effects of oxygen concentrators on oxygen levels in patients who developed COVID-19 pneumonia and were discharged on oxygen therapy.

MATERIAL AND METHOD

The study was designed as descriptive and analytical. The study received permission from the Republic of Türkiye Ministry of Health COVID-19 Scientific Research Review Committee. Ethical approval was obtained from the University of Health Sciences Ankara Training and Research Hospital, Clinical Research Ethics Committee on December 30, 2020. Written informed consent was obtained from patients who volunteered to participate.

The study included 42 patients aged ≥18 years who presented to the Ankara Training and Research Hospital Pulmonology Outpatient Clinic for follow-up between 01.01.2021 and 08.04.2021 and who had been hospitalised in our hospital for COVID-19 and discharged on an oxygen concentrator; and 66 patients aged ≥18 years who recovered from COVID-19, did not use an oxygen concentrator and presented to the pulmonology outpatient clinic for any reason. Sample calculations could not be made due to restrictions and curfews during the pandemic period. All patients who applied to our health institution and met the inclusion criteria were included in the study if they agreed. Participants received a sociodemographic data questionnaire and a questionnaire for determining the severity of COVID-19 infection, which were completed through face-to-face interviews. The sociodemographic data questionnaire included the following: age, sex, marital status, education level, occupation, smoking status, chronic diseases, medications used, other household members, symptoms experienced during COVID-19 infection, ongoing symptoms, previous stay at a hospital or intensive care unit for COVID-19 and the use of an oxygen concentrator (if yes, how many hours per day they received oxygen supplementation). The results of any chest X-ray or tomography imaging performed during infection were extracted from the electronic health system and recorded, and the oxygen saturation level of the patients was measured and recorded by the same researcher using a calibrated finger-type pulse oximeter device. During the study, all pandemic hygiene rules determined by the Ministry of Health were applied.

Statistical Analysis

Statistical analysis was performed using the IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp. software suite. Continuous variables were analysed for normality of distribution using the Kolmogorov–Smirnov test. In comparisons between groups, categorical variables were analysed using the Chi-squared test and Fisher's exact test, and continuous variables were analysed using the Mann–Whitney U test. For all statistical data, statistical significance was set at $p<0.05$.

RESULTS

The study included 108 patients, with 42 (38.9%) using an oxygen concentrator due to COVID-19 infection and 66 (61.1%) not using an oxygen concentrator. Of the participants, 53 (49.1%) were females, 55 (50.9%) were males, and the mean age was 58.03±13.62 years (22–86 years). An examination of the relationship between using an oxygen concentrator and certain sociodemographic characteristics revealed that there was no significant relationship between using an oxygen concentrator and the presence of chronic disease, regular medication use, or regular smoking, but patients in the concentrator group were found to be older and had statistically significantly lower levels of education ($p=0.001$; $p=0.03$, respectively) (**Table 1**).

Table 1. Correlation between using an oxygen concentrator and sociodemographic characteristics

Sociodemographic characteristics	Oxygen concentrator		p
	Yes (n=42)	No (n=66)	
Age			
Med (min - max)	65 (38-86)	57 (22-75)	0.001*
Gender			
Female / Male	21 / 21	32 / 34	1.0**
Education			
İlliterate	11	7	
Primary school	24	31	
Middle school	2	7	0.03**
High school	4	10	
University	1	11	
Working ststus			
Working	4	18	
Not working	21	26	0.08**
Retired	17	22	
Marital Status			
Married / Single	34 / 8	58 / 8	0.32**
Who lives at home			
Spouse	12	18	
Spouse and child	21	39	0.72**
Alone	1	1	
Other	8	8	
Disease			
Yes / No	34 / 8	48 / 18	0.33**
Medication use			
Yes / No	34 / 8	45 / 21	0.14**
Smoking			
Yes / No	1 /41	6 / 60	0.24**

* Mann Whitney U test, ** Chi Square.

The analysis of the correlation between symptoms experienced during COVID-19 infection and the use of an oxygen concentrator revealed that patients with dyspnea were mostly in the group that used an oxygen concentrator (p=0.002), whereas patients with headache and diarrhea were mostly in the group that did not require a concentrator (p=0.009; p=0.04, respectively) (**Table 2**).

The length of hospital stay for COVID-19 infection was found to be significantly higher in the group using an oxygen concentrator, with an average of 15 days (p=0.001). Patients who used an oxygen concentrator had higher rates of pulmonary involvement and lower oxygen saturation levels (p=0.001) (**Table 3**).

DISCUSSION

The use of aggressive oxygen therapy in the treatment of COVID-19 pneumonia is critical for disease recovery and mortality reduction.[5] Medical oxygen is a life-support therapy that is widely used in various diseases. Oxygen concentrators, a source of medical oxygen prescribed by physicians, are electrical, compact, easy-to-use and portable devices that produce oxygen from ambient air. It is an oxygen source that is preferred for use at home by patients receiving LTOT.[16] Home ventilatory support devices, such as oxygen concentrators, are widely used by patients with chronic respiratory failure and have been prescribed for COVID-19-related respiratory failure after the pandemic. The use of home ventilatory support devices has increased since

Table 2. Correlation between COVID-19 symptoms and the use of an oxygen concentrator

Symptoms	Oxygen concentrator		p
	Yes (n=42)	No (n=66)	
Fever			
Yes / No	23 / 19	31 / 15	0.43*
Dyspnea			
Yes / No	36 / 6	38 / 28	0.002*
Weakness-fatigue			
Yes / No	32 / 10	45 /21	0.37*
Muscle-joint pain			
Yes / No	21 / 21	40 / 26	0.27*
Sore throat			
Yes / No	4 / 38	3 / 63	0.42+
Dry cough			
Yes / No	19 / 23	24 / 42	0.35*
Phlegm cough			
Yes / No	2 / 40	5 / 61	0.70+
Postnasal drip			
Yes / No	0 / 42	1 / 65	1.0+
Visual impairment			
Yes / No	0 / 42	1 / 65	1.0+
Abdominal pain			
Yes / No	0 / 42	0 / 66	1.0+
Anorexia			
Yes /No	10 / 32	16 / 50	0.95*
Nasal discharge			
Yes / No	2 / 40	2 / 64	0.64+
Taste loss			
Yes / No	12 / 30	21 / 45	0.72*
Loss of smell			
Yes / No	10 / 32	24 / 42	0.17*
Sneeze			
Yes / No	0 / 42	0 / 66	1.0+
Headache			
Yes / No	4 / 38	21 / 45	0.009+
Nausea-vomiting			
Yes / No	4 / 38	14 / 52	0.18+
Diarrhea			
Yes / No	1 / 41	10 / 56	0.04+
Chest-back pain			
Yes / No	12 / 30	30 / 36	0.07*
Eye redness			
Yes / No	0 / 42	0 / 66	1.0+

+ Fisher's Exact Test, *Chi Square test.

Table 3. Correlation between using an oxygen concentrator and some parameters of COVID-19 infection

COVID-19	Oxygen concentrator		p
	Yes (n=42)	No (n=66)	
Hospitalization			
Yes / No	42 / 0	32 / 28	0.001+
Hospitalization			
Day	15 (3-36)	5.5 (0-55)	0.001*
SpO2	93.5 (70-99)	97 (92-99)	0.001*
PCR			
+ / -	40 / 2	57 / 9	0.19+
CT			
+ /- / none	42 / 0 / 0	44 / 9 / 13	0.001*

* Mann Whitney U test, + Fisher's Exact Test. SpO2: Peripheral capillary oxygen saturation. PCR: Polymerase Chain Reaction. CT: Computed Tomography

the COVID-19 pandemic.[17-19] Studies have shown that LTOT increases survival by improving lung function in patients with chronic respiratory failure. LTOT also improves the quality of life and reduces the frequency of recurrence and hospitalisation.[20-23]

Our study evaluated follow-up measurements of oxygen saturation levels in patients who were discharged on oxygen concentrators after developing respiratory failure from COVID-19 pneumonia. Patients who used a concentrator had lower oxygen saturation levels (mean SpO2 = 93.5), longer hospital stays (15 days) and more pulmonary involvement (100%). A study from China that analysed the data of 1099 patients hospitalised for COVID-19 reported an average hospital stay of 12.8 days. The same study reported that the incidence of pneumonia was higher in severe COVID-19 cases than in non-severe cases (89.5% vs. 99.4%), which is consistent with our study.[24]

The use of oxygen concentrators had no significant correlation with the presence of chronic diseases; however, patients who used oxygen concentrators were older and had significantly lower levels of education. Studies have shown that COVID-19 has a more severe course in elderly patients and in those with chronic diseases, and age is regarded to be the leading risk factor for critical illness.[25-27] In our study, patients requiring oxygen concentrators had a higher percentage of comorbidities, but the difference was not significant. This may be because of the small sample size. Guan et al.[24] found that patients with severe COVID-19 infection were 7 years older on average than those without severe infection. Our findings are consistent with the findings of previous studies in that the mean age of patients who used oxygen concentrators was 8 years older than the other group.

Dyspnoea is the most common symptom of severe COVID-19 infection and is often accompanied by hypoxia. Most patients develop progressive respiratory failure immediately after the onset of dyspnoea and hypoxemia.[26,28,29] Our study found that patients who complained of dyspnoea during COVID-19 infection were mostly in the group that used oxygen concentrators, while patients who complained of headaches and diarrhoea were mostly in the group that did not require a concentrator.

CONCLUSIONS

Patients who used an oxygen concentrator had lower oxygen saturation levels, but the mean value was higher (SpO2=93.5). This result shows that LTOT at home helped reverse lung damage and relieve hypoxemia in most patients. The use of oxygen concentrators in the treatment of COVID-19-related respiratory failure appears to be a good option that shortens the length of hospital stay in patients and reduces the burden on hospitals. Based on follow-up measurements of oxygen saturation values in the outpatient clinic, it is predicted that patients' requirements for oxygen therapy will not last long and are not likely to evolve into a chronic use. This situation should be taken into consideration for possible future pandemics. More extensive studies are needed on this subject.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study received permission from the Republic of Türkiye Ministry of Health COVID-19 Scientific Research Review Committee. Ethical approval was obtained from the University of Health Sciences Ankara Training and Research Hospital, Clinical Research Ethics Committee on December 30, 2020 (Desicion no: 519/2020).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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