Annals of Case Reports
Wang L. Ann Case Rep: 8: 1192
www.doi.org/10.29011/2574-7754.101192
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Research Article

# Combining Respiratory Training and Prone Positioning Improves the Recovery of COVID-19 Patients

**Ling Wang***

Department of Intensive Care Unit, People's Hospital of Qiandongnan Miao and Dong, Autonomous Prefecture, Kaili, Guizhou 556000, China

***Corresponding author**: Ling Wang, Department of Intensive Care Unit, People's Hospital of Qiandongnan Miao and Dong, Autonomous Prefecture, Kaili, Guizhou 556000, China

**Citation**: Wang L (2023) Combining Respiratory Training and Prone Positioning Improves the Recovery of COVID-19 Patients. Ann Case Report. 8: 1192. DOI:10.29011/2574-7754.101192

**Received:** 23 February 2023, **Accepted:** 27 February 2023, **Published:** 01 March 2023

## Abstract

**Background:** The common type of Coronavirus Disease 2019 (COVID-19) can evolve into a severe illness, showing a high fatality rate. In these cases, all effective measures to promote recovery are required. **Purpose:** To study the efficacy of combining respiratory training and prone positioning in improving the recovery of COVID-19 patients. **Methods:** Patients presenting the common type of COVID-19 were enrolled and divided into experimental and control groups. The control group received antiviral, anticoagulant, and comorbidity treatments, as well as nutritional support and symptomatic treatment; the experimental group also performed additional respiratory training and prone positioning under the guidance of the rehabilitation and nursing staff. The number of severe illness cases, the lung lesion area within seven days of admission, and the length of hospital stay were analysed. **Results:** The experimental and control groups displayed no significant differences in terms of sex, age, comorbidity scores, onset-to-door time, CRB-65 scores, and oxygenation index at admission ($\chi 2/t$ /u =0.681, 0.461, -0.284, 0.677, 0.052, -0.447;$P > 0.05$). The experimental group showed fewer cases of severe illness ($\chi$=-3.250, P=0.002), reduced lung lesion area (t=2.770, P=0.008), and lower length of hospital stay (t=-2.576, P=0.011) compared with the control group. **Conclusions:** These results suggest that the combination of respiratory training and prone positioning improves the recovery of COVID-19 patients.

**Keywords:** Novel Coronavirus; COVID-19; SARS-Cov-2; Respiratory Training; Prone Positioning

## Introduction

Coronavirus disease 2019 (COVID-19) has resulted in millions of deaths worldwide. It is still a global problem; thus, the healthcare system faces serious challenges. Reducing the rate of severe illness cases and decreasing the length of hospital stay are essential for promoting patient recovery and reducing healthcare resource consumption. The exact pathophysiological process by which COVID-19 develops into severe illness remains elusive [1]. Acute respiratory distress syndrome occurs in most of these patients. Several therapeutic approaches have been proposed to address this symptom. The prone positioning can increase the alveolar ventilation in the gravity-dependent area near the diaphragm and the airway secretion drainage, improving lung compliance [2]. Respiratory training can preserve intercostal muscle strength, prevent diaphragm atrophy, and maintain ventilator drive function [3]. This study aimed to evaluate the efficacy of combining respiratory training and prone positioning to improve clinical treatment and recovery of COVID-19 patients.

## Materials and Methods

**Subjects:** COVID-19 patients who were admitted to Zhabei Central Hospital, Jing An District, Shanghai, China, from May 1,

2022, to May 22, 2022, were enrolled.

**Inclusion criteria:** patients older than 18 years, with a positive new coronavirus nucleic acid test and an admission diagnosis of the common type of COVID-19. China's diagnosis and treatment guidelines have classified COVID-19 as asymptomatic, mild, common, severe, and critical [4].

**Exclusion criteria:** inability to perform rehabilitation exercises, respiratory training or prone positioning, comorbid bacterial infection, and incomplete clinical data.

## Diagnostic criteria

**COVID-19 common type:** respiratory symptoms such as fever and cough; small patch shadow and interstitial changes in the lung observed on the computerised tomography (CT) scan, with obvious extra pulmonary zone or multiple pulmonary ground-glass shadows; positive new coronavirus nucleic acid test; and no life-threatening changes in vital signs.

**COVID-19 severe illness:** shortness of breath and respiratory rate of >30 times/min in a quiet state; oxygen saturation ≤93% when inhaling air; arterial oxygenation index (oxygen partial pressure/oxygen concentration) ≤300 mmHg; the clinical symptoms were progressively worse, and the pulmonary lesions progressed more than 50% within 24-48 hours.

## Treatment

**Conventional treatment [4]:** Antiviral, Paxlovid 400 mg once every 12 hours for five consecutive days; anticoagulation, low-molecular-weight heparin 80 u/kg, once every 12 hours until discharge; convalescent plasma, used at an early stage in patients with high-risk factors, high viral load, and rapid disease progression, at an infusion dose of 200-500 mL (4-5 mL/kg); immunotherapy, methylprednisolone 40 mg, once every day for not more than seven days, in case of lung disease progression of more than 50% within 24-48 hours; individualised basic disease control, nutritional support, psychological comfort, and supportive treatment.

**Respiratory training:** We used the Active Circulation Breathing Technology. A circulation cycle consisted of breath control, chest expansion, and forced expiratory technique. In the respiratory control stage, the patient was instructed to breathe with normal tidal volume using the relaxation method (keeping the shoulder and upper chest relaxed, actively contracting the lower chest and abdomen) and complete the breathing cycle using the diaphragmatic breathing technique. The duration of this stage was adapted to the patient's needs. In the thoracic expansion stage, the emphasis was put on inspiration. The patient was instructed to inhale deeply to the inspiratory reserve, hold his breath for 1-2 seconds, and then exhale passively and easily. The forced expiratory phase was interspersed with breath control and exhalation. Exhalation was rapid, and the glottis remained open. To reduce the work of respiratory muscles, we used the breathing technique to expel phlegm instead of coughing. Breathing pattern training included breathing rhythm adjustment (inhalation: exhalation=1:2), abdominal breathing training, pursed-lip breathing training, etc., 4-6 times/day Figure 1.

**Prone positioning:** The patient lied on the abdomen with the head turned to one side or supported on the head frame. A large soft pad was placed on both sides of the chest so that the thoracoabdominal region was draped; the thoracic and abdominal breathings were not restricted. The two upper extremities were placed on each side of the head, and one soft pad was placed on each foot and knee so that the knee was not stressed and the ankle joints were naturally flexed and sagged [5]. The total daily prone position time was greater than 6 hours Figure 2.


**Figure 1:** One of the respiratory training pictures.


**Figure 2:** One of the prone positioning pictures.

## Research Methods

This was a prospective study. Intervention methods: All patients received the conventional treatment. Under the rehabilitation and nursing staff's guidance, the experimental group increased the respiratory training and prone positioning. The control group did not take respiratory training and prone positioning. Age, gender, comorbidity score, onset-to-door time, CRB-65 score, and oxygenation index were collected on admission. Patients were randomly divided into experimental and control groups. We compared the number of cases that evolved to severe pneumonia after seven days, the reduction of the lung lesion area, and the total hospital stay.

**Statistical analysis:** Statistical analysis was performed using SPSS software (Version 25.0; SPSS Inc,Chicago,Ill). The Kolmogorov-Smirnov test was used to examine the data's normal distribution. Normally distributed data were expressed as mean ± standard deviation (SD). Then, the independent samples t-test was carried out for group comparison, while the Chi-square ($\chi 2$) test was performed to compare categorical variables. Measurements with unequal variances were tested with the non-parametric Mann-Whitney test. The significance level was set at $P < 0.05$.

## Results

We observed no significant differences between the experimental and control groups in terms of sex, age, comorbidity scores, onset-to-door time, CRB-65 scores, and oxygenation index at admission ($\chi 2/t/u = 0.681, 0.461, -0.284, 0.677, 0.052, -0.447$, respectively; $P > 0.05$). The data sets of the two groups were consistent. When compared with the controls, the experimental group showed fewer cases of severe illness ($\chi$=-3.250, P=0.002), a greater reduction of lung lesion area (t=2.770, P=0.008), and a lower length of hospital stay (t=-2.576, $P < 0.011$) (Table 1).

| parameter | experimental group (n=76) | control group (n=80) | $\chi^2$/t /u | *P* |
|---|---|---|---|---|
| Gender (male / female, n) | 56/20 | 52/28 | 0.681 | 0.280 |
| Age (y) | 71.11±8.32 | 68.40±5.18 | 0.461 | 0.646 |
| Complication score (point) | 2.33±0.98 | 2.45±1.03 | -0.284 | 0.777 |
| Onset time (d) | 2.78±2.55 | 2.69±2.37 | 0.677 | 0.500 |
| CRB-65 score (point) | 1（1, 2） | 1（1, 2） | 0.052 | 0.820 |
| Oxygenation index (mmHg) | 343.32±8.24 | 349.58±9.56 | -0.447 | 0.741 |
| Severe illness cases (n) | 5* | 11 | -3.250 | 0.002 |
| Reduction value of lung focus area ($cm^2$) | 30.22±6.67* | 25.01±9.55 | 2.770 | 0.008 |
| Length of hospital stay (d) | 8.17±1.06* | 10.23±1.24 | -2.576 | 0.011 |
| Note: compared with the control group, P<0.05 | | | | |

**Table 1:** Comparison of required data between experimental group and control group.

## Discussion

The COVID-19 pandemic is a global disaster. There is no doubt about the importance of preventing COVID-19 from developing into severe illness by reducing the average length of hospital stay and accelerating rehabilitation. This study demonstrated that combining respiratory training and prone positioning could reduce the number of COVID-19 severe illness cases. The lung lesion absorption rate in the experimental group was higher than in the control group, and the length of hospital stay was shortened. These results suggest that combining respiratory training and prone positioning improves the recovery of COVID-19 patients.

**Respiratory training:** COVID-19 patients usually have decreased pulmonary function due to respiratory complications and functional degradation [6]. Studies have shown that respiratory training improved the pulmonary function of COVID-19 patients by promoting respiratory muscle movement and relieving muscle pain [7-9]. Some studies recommend the Trinity breathing exercises, abdominal breathing training, pursed-lip breathing training, etc., for patients with COVID-19 common type [10]. Moreover, a recent report has shown that early lung rehabilitation training might help improve clinical symptoms and lung lesion absorption [11]. Early respiratory

exercises have also been recommended by relevant guidelines [12].

**Prone positioning:** the prone positioning can increase alveolar ventilation in the gravity-dependent area near the diaphragm and the airway secretion drainage. Studies have shown that prone ventilation improved patients' oxygenation, shortened the hospital stay and mechanical ventilation time in severe illness, and reduced the 28-day and 90-day mortality [13]. The guidelines on managing critically ill adults with COVID-19 recommend prone ventilation for 12-16 hours/day [14]. Moreover, prone ventilation can improve oxygen flow and reduce the respiratory effort in conscious COVID-19 patients, minimising the risk of spontaneous lung injury [13,15-17]. The application of prone positioning in COVID-19 patients was supported by the General Office of the National Health Commission of the People's Republic of China [4].

We believe that the combination of respiratory training and prone positioning can improve COVID-19 patients' recovery. This combined technique-enhanced patients' muscle strength and respiratory drive, effectively preventing acquired weakness and improving the systemic immune function. In addition, the prone positioning improved lung compliance, posture drainage, ventilation/blood flow ratio, and tissue oxygenation. The combined rehabilitation therapy has the advantages of being non-invasive, having good repeatability, and low cost. However, the author would like to state that antiviral and antithrombotic treatments are indispensable for COVID-19 patients and cannot be replaced by this rehabilitation therapy. In China, traditional Chinese medicine and acupuncture can also help body recovery [18,19]. This study has some limitations: it did not consider the influence of drug efficacy, the immune status of the patient, and the treatment of underlying conditions on COVID-19 progression. We will address these issues in future in-depth studies by conducting subgroup analyses.

**Competing interests:** The authors have no conflicts of interest to declare

**Funding:** Guizhou Science and Technology Support Plan ([2020] 4Y139); Qiandongnan Miao and Dong Autonomous Prefecture Science and Technology Support Plan ([2021]12); Cultivation of High-Level Innovative Talents in Guizhou Province ([2022]201701).

**Acknowledgement:** We appreciate the linguistic assistance provided by TopEdit (www.topeditsci.com) during the preparation of this manuscript.

## References

1. Dixit S (2021) COVID-19 and Its Pathophysiology [J], Psychology (Savannah, Ga.), 58: 487-494.
2. Concha P, Treso-Geira M, Esteve-Sala C, Prades-Berengue C, Domingo-Marco J, et al (2021) Invasive mechanical ventilation and prolonged prone position during the COVID-19 pandemic-ScienceDirect [J]. Medicina Intensiva (English Edition), 46: 161-163.
3. Kader M, Hossain M A, Reddy V, Perera NKP, Rashid M (2022) Effects of short-term breathing exercises on respiratory recovery in patients with COVID-19: a quasi-experimental study [J]. BMC Sports Science, Medicine and Rehabilitation, 14.
4. General Office of National Health Commission of the People's Republic of China (2021) Office of National Administration of Traditional Chinese Medicine of the People's Republic of China. Diagnosis and treatment plan for novel coronavirus pneumonia (trial version 9) [J]. China Medicine, 17: 481-487.
5. Xu Y, Meng M, Liu J, Chen DC (2021) Actual operation process of prone position ventilation in patients with severe novel coronavirus pneumonia [J]. Chinese critical care medicine, 33: 393-398.
6. Huang B, Xie H, Shi P (2020) Epidemiology and clinical features of 6 cases with novel coronavirus pneumonia [J]. practical Journal of clinical Medical, 17: 66-69.
7. Barker-Davies RM, O'Sullivan O, Senaratne KPP, Baker P, Cranley M, et al (2020) The Stanford Hall consensus statement for post-COVID-19 rehabilitation [J]. Br J Sports Med, 54: 949-959.
8. Xiao YJ, Dong X, yang HZ, tan HY, Zhou RL, et al (2021) Clinical features of 141 fatal cases of coronavirus disease in Jinyintan Hospital in Wuhan, China [J]. Chinese Journal of tuberculosis and respiration, 44: 354-359.
9. Chinese society of integrated traditional and Western Medicine (2020) Expert consensus on the prevention and treatment of novel coronavirus pneumonia with integrated traditional Chinese and Western Medicine [J]. Chinese Journal of integrated traditional and Western medicine, 40: 1413-1423.
10. Lopez M, Bell K, Annaswamy T, Juengst S, Ifejika N (2020) COVID-19 Guide for the Rehabilitation Clinician: A Review of Nonpulmonary Manifestations and Complications [J]. Am J Phys Med Rehabil, 99: 669-673.
11. Zhao JM, wang BL, wang YH (2021) Clinical study of correlation between clinical symstoms and changes of chest CT image applying pulmonary rehabilitaion training at early stage in the COVID-19 patients [J]. International Journal of respiration, 41: 121-126.
12. Yang F, Liu N, Wu JY, Su GS, Zhong NS, et al (2020) Pulmonary rehabilitation guidelines in the principle of 4S for patients infected with 2019 novel coronavirus (2019-nCoV) [J]. Chinese Journal of Physical Medicine and Rehabilitation, 42: 864-864.
13. Guérin C, Albert RK, Beitler J, Gattinoni L, Jaber S, et al (2020) Prone position in ARDS patients: why, when, how and for whom [J]. Intensive Care Med, 46: 2385-2396.
14. Alhazzani W, Møller MH, Arabi YM, Loeb M, Gong MN, et al (2020) Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19) [J]. Crit Care Med, 48: e440-e469.

15. Subgroup of Critical Respiratory Disease, Chinese Society of Critical Care Medicine, Chinese Medical Association (2020) Standardized protocol of prone position ventilation in patients with acute respiratory distress syndrome [J]. Chin J Intern Med, 59: 781-787.

16. Liu CX, Dai XM, Huang W (2021) International clinical research progress in critical care medicine in 2020 [J], Chinese Critical Care Medicine, 33: 5-9.

17. Coppo A, Bellani G, Winterton D, Pierro MD, Soria A, et al (2020) Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study [J]. Lancet Respiratory Medicine, 8: 765-774.

18. Zhang L, Yu J, Zhou Y, Shen M, Sun L, et al (2020) Becoming a faithful defender: traditional Chinese medicine against coronavirus disease 2019 (COVID-19) [J]. American Journal of Chinese Medicine, 48: 1-15.

19. Han Z, Zhang Y, Wang P, tang Q, Zhang K, et al (2021) Is acupuncture effective in the treatment of COVID-19 related symptoms? Based on bioinformatics/network topology strategy [J]. Briefings in Bioinformatics, 22: bbab110.