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CASE REPORT

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The effect of lung recruitment maneuverer in COVID-19 induced acute respiratory distress syndrome

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Abstract

Coronavirus disease-2019 (COVID-19) is a highly spread infectious disease around the world. This infectious disease impacts whole body systems, specifically on respiratory system. This 57-year-old women had diagnosed COVID-19 positive and progress to acute respiratory distress syndrome (ARDS) within 1 week. Mechanical ventilation with protective lung strategy, prone position could not reverse the worsen hypoxemia and bilateral lung infiltration. Recruitment manoeuvre was proceeded with 40–40 strategy and protective/ventilation tool (P/V tool). After 4 days (8 rounds) of recruitment manoeuvre, oxygenation level and lung compliance showed dramatic improvement. The patient was finally extubated at COVID-19 Day 40 and discharged with long term oxygen use at COVID-19 Day 60. In this case, we report how recruitment manoeuvre can improve severe hypoxemia and bilateral lung infiltration dramatically in ARDS.

KEYWORDS
acute respiratory distress syndrome, COVID-19, recruitment manoeuvre

INTRODUCTION

A novel, quickly spreading infectious disease was first identified in 2019 Wuhan, China. This infectious disease was confirmed and named Coronavirus Disease-2019 (COVID-19) by the world health organization (WHO) and declared a public health emergency of international concern (PHEIC). COVID-19 influences the whole respiratory system, bilateral infiltration in chest x-ray and hypoxemia were found clinically. Patients will eventually progress to acute respiratory distress syndrome (ARDS), and this type of ARDS was called Type L ARDS due to its pathological characteristics of low elastance in serials of studies.[1] Mechanical ventilator with lung protective strategy (LPS) can prevent ventilator induced lung injury (VILI). But under some circumstances, even higher PEEP cannot prevent or correct atelectasis or hypoxemia. Prone position (PP) and recruitment manoeuvre (RM) would then be considered.[2] Our patient was diagnosed with COVID-19 induced ARDS and progressed from Type L to Type H. The progression of infiltration and hypoxemia was very rapid and poorly controlled with high PEEP and PP. This case report discusses the effect of recruitment manoeuvre in an ARDS patient who was infected by COVID-19.

CASE REPORT

This 57-year-old female had hypertension as history. She is 160 cm height and 54 kg as predict body weight (PBW).

She was diagnosed COVID-19 on 2021/05/30 through Polymerase chain reaction (PCR). RNA sequence showed alpha variant, cycle threshold value was 20.99. After admission, simple oxygen mask was given for hypoxemia. Due to persistent hypoxemia, she was intubated on 2021/06/03 (COVID-19 Day 5). We started LPS which according to ARDS network recommendation, include lower VT, higher PEEP, permissive hypercapnia (keep pH > 7.25) and lower saturation level (keep SpO_2 > 88% or PaO_2 > 60 mmHg). After LPS, dynamic lung compliance (Cdyn), lower PaO_2/FiO_2 ratio (P/F ratio) and progressive infiltration worsen between COVID-19 Day 5 to 25. (Figures 1 and 2) We proceeded with PP for persistent hypoxemia. However, the effect of PP was limited, some complications (bradycardia and hypotension) were found. Due to these complications, PP was suspended. But hypoxemia was persistent, thus we started RM. We performed RM twice daily between 2021/06/23-26 (COVID-19 day 25–28). Initial strategy of RM was 40–40. We proceeded in CPAP (Continuous Positive Airway Pressure) mode with PEEP level 40cmH_2O for 40 s. We determined that PEEP 14cmH_2O was the optimal PEEP for this case. After the 40–40 strategy, we changed our strategy to Protective Ventilation Tool (P/V tool) which is already built-in our ventilator (Hamilton G5, Hamilton Medical, Switzerland). We set Pstart 0 cmH_2O, Ptop 35cmH_2O, Ramp speed 3cmH_2O/s, End PEEP 0 cmH_2O and Tpause 30 s. We started the first round of RM under the setting described above, and determined LIP (Low Inflation Point), UIP (Upper Inflation Point) and PDR (Point of De-Recruitment). We set new Pstart as 0, Ptop as UIP-2cmH_2O, End PEEP as PDR and Tpause 30 s for the further recruitment (Figure 3). After a total of 8 times of RM, we noted a dramatic improvement in lung compliance and Chest X-ray at COVID-19 Day 30 (Figure 2). Our patient was then extubated and used high flow nasal cannula (HFNC) at COVID-19 Day 40. She was discharged from our hospital with long-term oxygen therapy at COVID-19 Day 60.

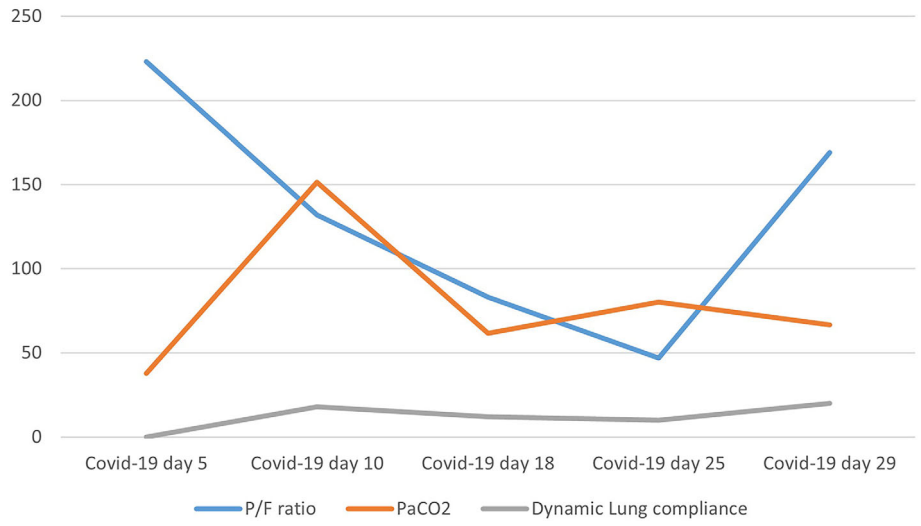

FIGURE 1 Respiratory physiology trend between COVID-10 Day 5–29

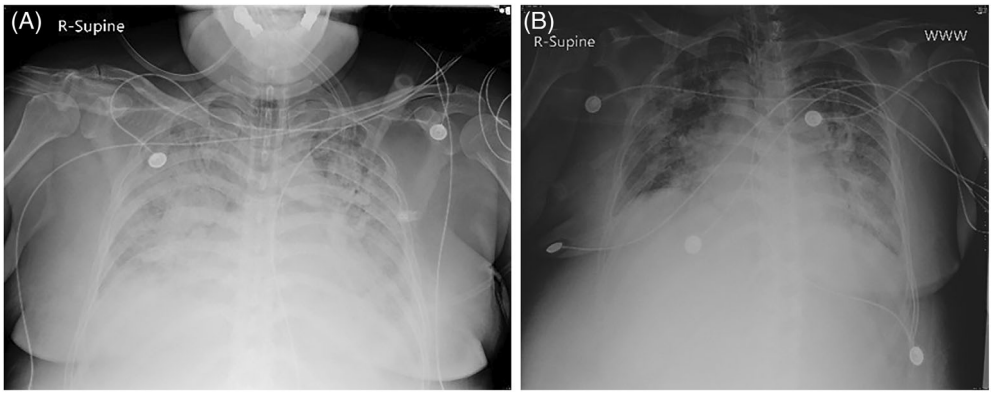

FIGURE 2 (A) Chest X-ray on COVID-19 Day 25 and (B) Chest X-ray on COVID-19 Day 28

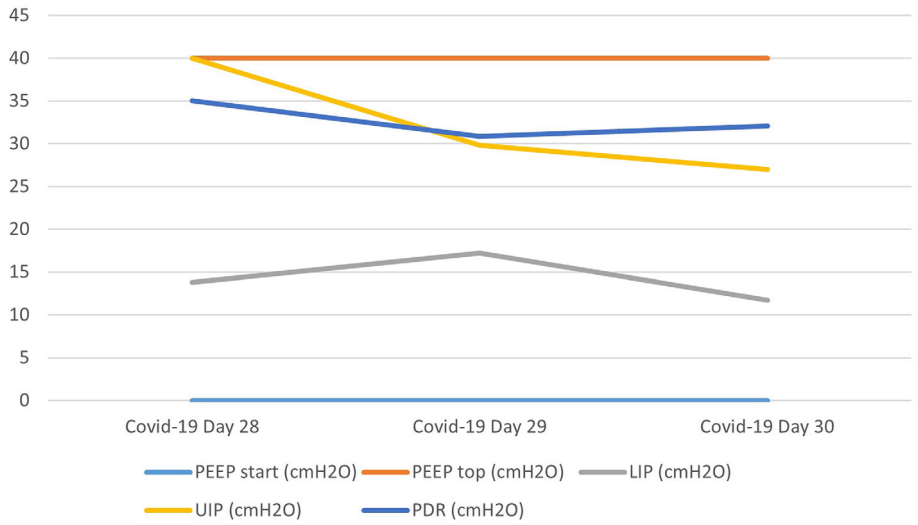

FIGURE 3 Data of recruitment manoeuvre

DISCUSSION

Unlike traditional ARDS, COVID-19 induced ARDS has a largely different effect on lung mechanism. Clinically, COVID-19 induced ARDS has higher static lung compliance (Cst) and lower elastic recoil. This type of ARDS is also called Type L.[3] Our patient had higher lung compliance initially which is diagnosed as Type L ARDS. But as the disease progressed, lung compliance worsen and shifted to Type H ARDS (traditional type). This changing is based on the progression of inflammation of the lung.[1] Type H ARDS has lower lung compliance and lower oxygenation. Mechanical ventilation, PP and recruitment manoeuvre could be used to deal with lower compliance and oxygenation. PP can re-open the collapsed lung in dependent part, which have benefits on oxygenation and mortality rate.[2] RM is another way to re-open the collapsed lung, but different studies reported different outcomes. In previous systemic reviews, higher PEEP improved hypoxemia and lowered the incidence of VILI.[4] After reviewed many studies, PP and RM indeed can improve hypoxemia but the influence on prognosis are still reserved. Our patient improved oxygenation despite benefit was limited after PP. Due to complications (bradycardia, hypotension, and sputum impaction), we changed strategy to RM with higher PEEP level for better lung compliance, oxygenation and outcomes compared to PP. These positive outcomes could also be found in chest x-ray and computed tomography. Our patient could be extubated at COVID-19 day 40, and discharged at COVID-19 day 60. Respiratory therapists have different methods and tools to perform RM, such as 40–40 strategy, low flow PV (Drager, Germany) and P/V tool. In pressure/volume (P/V) loop, we could determine lower inflation point (LIP), upper inflation point (UIP) and point of de-recruitment (PDR). These three different points allowed us to assess the change in lung volume and lung compliance.[5] We thus could set PEEP level at the pressure that have better lung compliance and larger lung volume.

In conclusion, we reported that RM can indeed improve persistent hypoxemia and poor lung compliance in COVID-19 induced ARDS. Our patient did eventually reach the goal of extubation and discharge. However, this benefit should be investigated by further clinical trial to confirm its benefit.

AUTHOR CONTRIBUTIONS

Conceptualization: Wei-Chiang Lin; Resources, Shang-Yi Lin, Meng-Che Tsai, Wei-Chiang Lin. *Supervision*: Hsiu-Mei Chang. *Validation*: Fu-Tsai Chung.; *Writing*: Wei-Chiang Lin. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The authors declare that appropriate written informed consent was obtained for the publication of this manuscript and accompanying images.

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