Effect of prone position on respiratory work and gas exchange during spontaneous breathing in patients with acute hypoxemic respiratory failure due to COVID-19 pneumonia

E. Chiodaroli*, P.D. Wendel Garcia°, S. Cappio Borlino^, M. Pitimada*^, C. Granata^, G. Zuanetti^, S. Roli^, M. Bonifazi*^, P. Formenti*, L. Bolgiaghi*, S. Coppola*, D. Chiumello*§

*Department of Anesthesia and Intensive Care, ASST Santi Paolo e Carlo, San Paolo University Hospital, Milan, Italy; °Institute of Intensive Care Medicine, University Hospital of Zurich, Zurich, Switzerland; ^Department of Pathophysiology and Transplantation, University of Milan, Milan, Italy; §Department of Health Sciences, University of Milan, Milan, Italy

Introduction

Patients with SARS-CoV-2 infection can develop acute hypoxemic respiratory failure (AHRF) characterized by high levels of respiratory work that, if not recognized, can lead to non-invasive ventilation failure. Despite clear advancements in this field, we still lack knowledge about respiratory work during spontaneous breathing and effective strategies to reduce it. Aim of the present study was to investigate the effect of prone position on respiratory mechanics and gas exchange during spontaneous breathing in patients with AHRF due to COVID-19 requiring helmet CPAP.

Methods

Prospective enrolment of adults (>18 years) with AHRF due to, radiologically and laboratory confirmed, COVID-19 pneumonia. Inclusion criteria: PaO_2/FiO_2 ratio <300 mmHg and/or respiratory distress, requiring helmet CPAP. Exclusion criteria: unstable hemodynamics and Glasgow coma scale <15. Blood gas analyses, respiratory mechanics, measured by bioelectrical impedance, and oesophageal pressures, measured by oesophageal manometry, were collected during supine position and 3 hours after the initiation of prone position. For statistical analysis, a fully scripted data management pathway was created within the R environment for statistical computing, version 3.6.1.

Results

Among the 44 enrolled patients median age was 59 [53–68] years. Prone positioning was associated with a PaO_2/FiO_2 ratio increase from 171 [138–239] mmHg to 328 [236–406] mmHg ($p<0.001$), representing a percentage increase of 65 [41–121] % (Figure 1A). Respiratory work, estimated as the product of oesophageal pressure, tidal volume and respiratory rate, decreased from supine (65 [46–89] cmH_2O*L/min) to prone position (51 [34–67] cmH_2O*L/min) ($p<0.001$), with a percentage decrease of -21 [-35 – -9] % (Figure 1B).

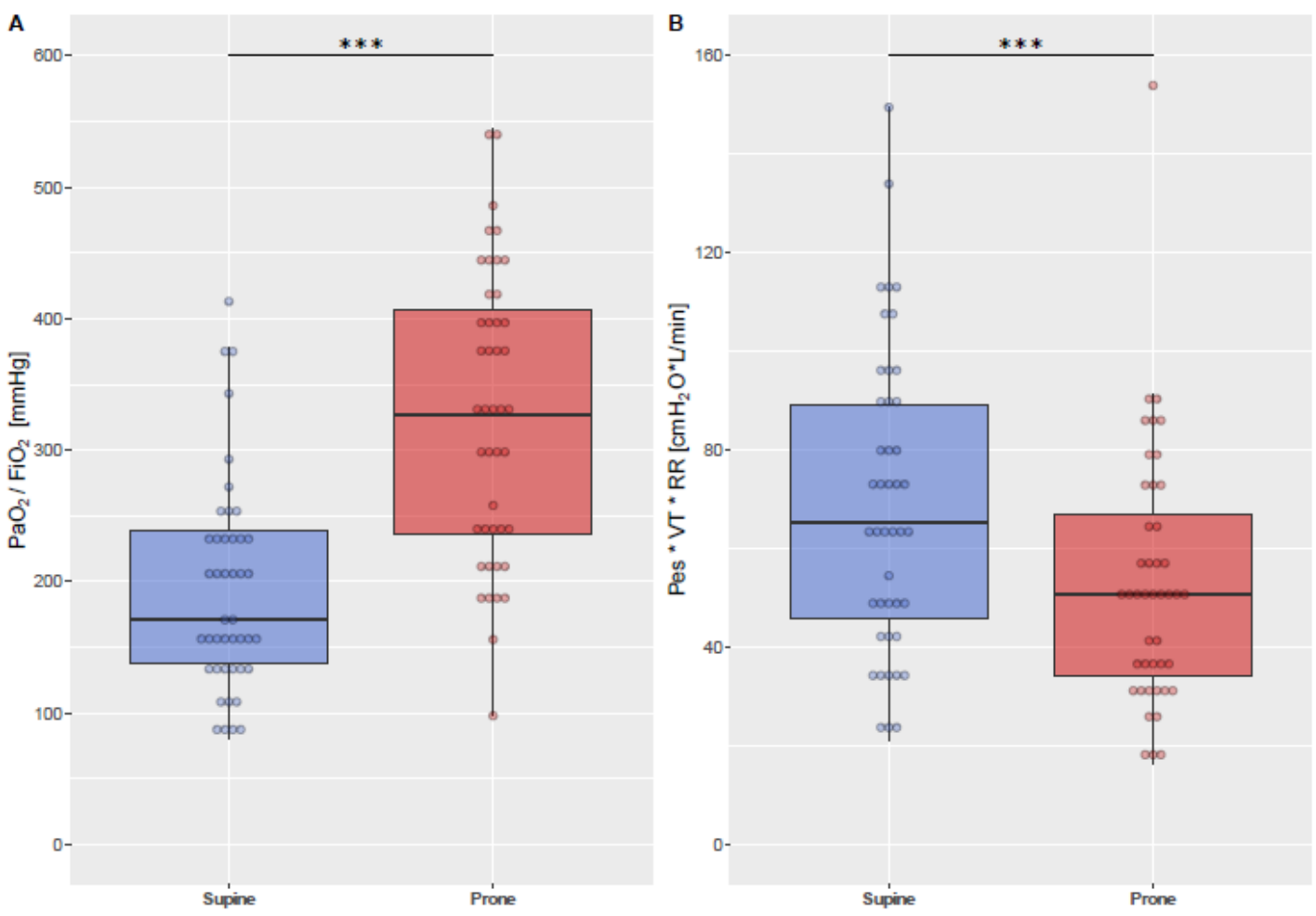

Figure 1. Response to prone position. Box plots present the change in **(A)** PaO_2/FiO_2 ratio and **(B)** respiratory work (expressed as the product of oesophageal pressure (Pes), tidal volume (VT) and respiratory rate (RR)) 3 hours after the initiation of prone position. *** $p < 0.0001$

Conclusions

In this prospective cohort of spontaneously breathing patients affected by AHRF due to COVID-19 pneumonia, prone positioning was associated with an improvement in both gas exchange and respiratory mechanics. Widespread implementation of this easy to perform intervention could prove essential in improving critical care of non-invasively ventilated patients.