con cargas virales altas aún en pacientes con enfermedad prolongada.

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Anexo. Material adicional

Se puede consultar material adicional a este artículo en su versión electrónica disponible en doi:10.1016/j.medin.2022.07.001.

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Prone position improves ventilation-perfusion mismatch in patients with severe acute respiratory distress syndrome

La posición prono mejora el desajuste ventilación-perfusión en pacientes con síndrome de distrés respiratorio agudo

Acute respiratory distress syndrome (ARDS) is a frequent condition in the intensive care unit (ICU).[1] It is clinically manifested by hypoxemic respiratory failure, airspaces flooding by inflammatory edema, and regional lung collapse due to ''gas compression'' of the dependent lung regions.[2] Hypoxemia is due to a ventilation/perfusion mismatch, especially in a heterogeneously ventilated and perfused lung.[3] Prone positioning (PP) has shown to improve oxygenation and survival in selected ARDS patients. In addition, PP has been associated with recruiting of dorsal lung regions, with a more homogeneous ventilation and a reduction of pleural pressure gradient contributing with an improvement in the ventilation/perfusion (V/Q) ratio.[4,5]

Electrical Impedance Tomography (EIT) is a bedside non-invasive monitoring tool of ventilation and perfusion distribution. Several studies have demonstrated EIT's benefits in establishing ventilatory parameters and its role in assess the lung perfusion in ARDS.[6] Thus, in this study we aimed to analyze PP's effects on the distribution of pulmonary ventilation and perfusion in patients with severe ARDS connected to mechanical ventilation (MV).

These data were presented preliminary as a poster in ESICM 2021.[7]

This is an observational sub-study of an already finished clinical study (Nº 170315007) which was conducted on patients admitted to the Intensive Care Department of the Hospital Clínico UC-Christus (Santiago, Chile), between November 2019 and March 2020 and required EIT as part of the ventilatory multimodal monitoring protocol. Considering that EIT perfusion measurements were indicated by attending physicians as an alternative diagnostic approach (i.e., thromboembolic disease), a waiver to use this data was requested to the ethical-scientific committee of the Pontificia Universidad Católica de Chile (Nº 210510004).

Patients with moderate to severe ARDS were included. PP was indicated by the attendant physician according to ICU protocols. The distribution of pulmonary ventilation and

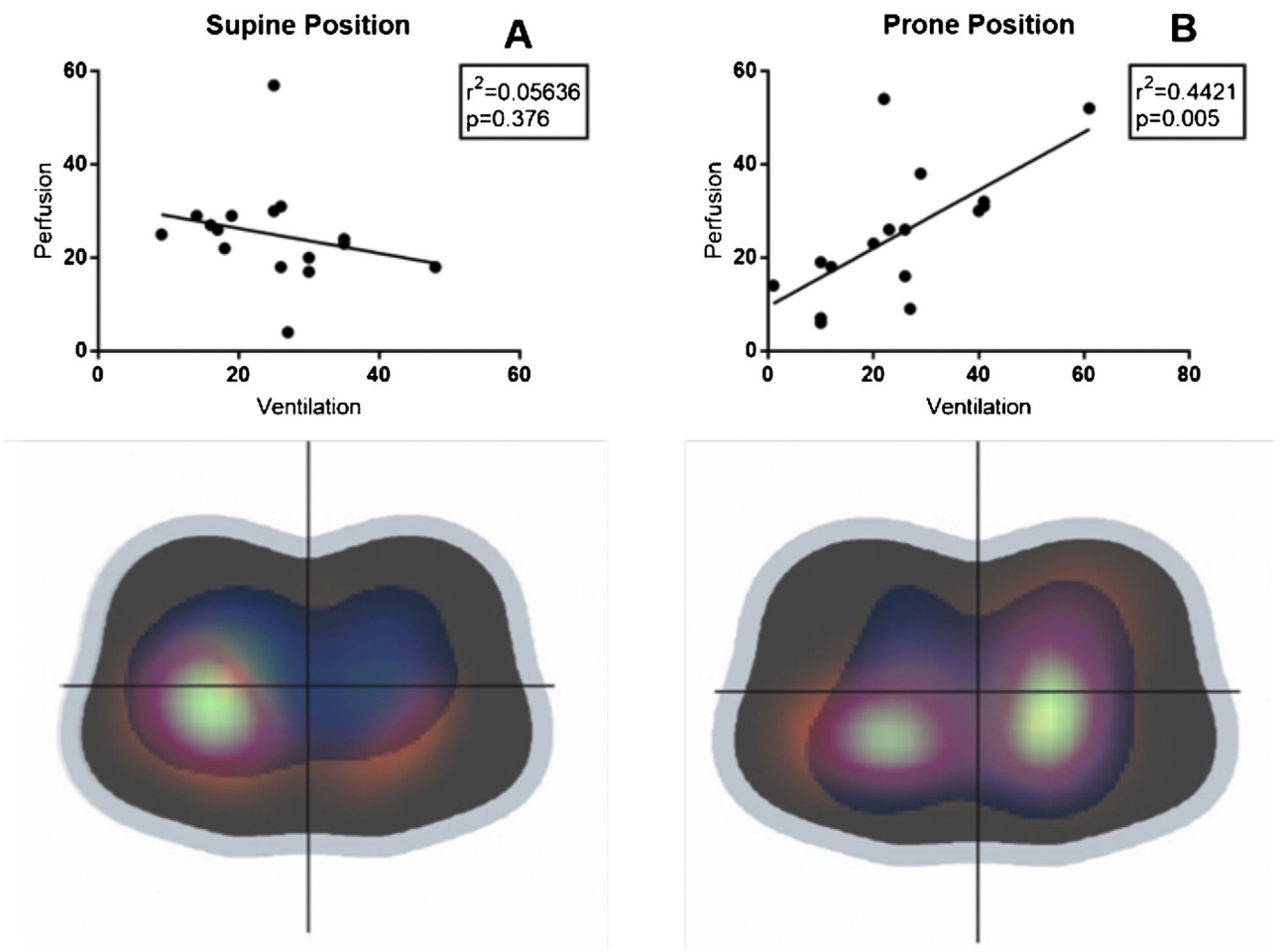

Figure 1 Regional distribution of ventilation and perfusion in the supine (A) and prone (B) position. Solid lines are regression lines between ventilation and perfusion at both positions. Distributions are expressed as a percentage of the regional variation (quadrants).

perfusion was evaluated with EIT (Enlight 1800, Timpel, São Paulo, Brazil) in the supine position (SP) and then in prone 2 h after proning. Impedance Ratio (IR) and Global Inhomogeneity (GI) indices were obtained from the EIT data, and arterial blood gases, hemodynamic parameters, and ventilatory mechanics were registered in each position.

The ventilation and perfusion maps delivered by EIT were divided into four regions of interest (quadrants), and in two gravitational regions (ventral and dorsal). For the regional analysis of the V/Q relationship we used the Pearson Correlation Coefficient. Values are expressed as mean ± standard deviation (SD). Comparisons of physiological changes between SP and PP were performed with paired Student's t-test, using GraphPad Prism (GraphPad Software, San Diego, CA, USA). The level of significance was established at a P-value ≤ 0.05.

Eight patients with pneumonia (57 ± 11 years, 50% female) were included. Hemodynamic parameters were similar in both positions.

During PP, we found a significant increase in PaO_2/F_IO_2 (206 ± 32 vs. 125 ± 34 mmHg, $p < 0.005$) and in respiratory system compliance (33.8 ± 6 vs. 30.3 ± 6 ml/cmH_2O, $p = 0.02$), associated to a decrease in driving pressure (10.8 ± 2.1 vs. 12.3 ± 2.5 cmH_2O, $p = 0.04$), as compared to SP. PEEP setting was 9.4 ± 2.9 cmH_2O during PP, and 9.2 ± 3.7 cm H_2O during SP.

We observed a redistribution of ventilation (Impedance ratio) from ventral regions in SP to dorsal regions in PP in all patients (0.77 ± 0.3 to 2.23 ± 0.9 AU, $p = 0.007$). Such rearrangements were associated with ventilation homogenization, as indicated by a decrease in GI from 1.24 ± 0.3 to 0.82 ± 0.1 (AU) ($p = 0.02$).

Four of the eight patients were subjected to pulmonary perfusion assessment. Perfusion was predominantly dorsal in both SP and PP. Regional distribution of ventilation and perfusion (quadrants) exhibited a positive linear correlation in PP ($R^2 = 0.44$, $p = 0.005$), but not in SP ($R^2 = 0.056$, $p = 0.37$) (Fig. 1), suggesting the optimization of the V/Q mismatch with PP. In addition, we observed a good correlation ($R^2 > 0.9$) between changes of PaO_2/FiO_2, dorsal V/Q ratio, and the change of respiratory system compliance (Fig. 2).

This observational study suggests that prone PP in mechanically ventilated patients with ARDS was associated with a change in the ventilation distribution pattern to dorsal lung regions; and homogenization of gas and perfusion distribution, resulting in improved V/Q ratio. In addition, the change of dorsal V/Q ratio was good correlated with the individual change of oxygenation and respiratory mechanics.

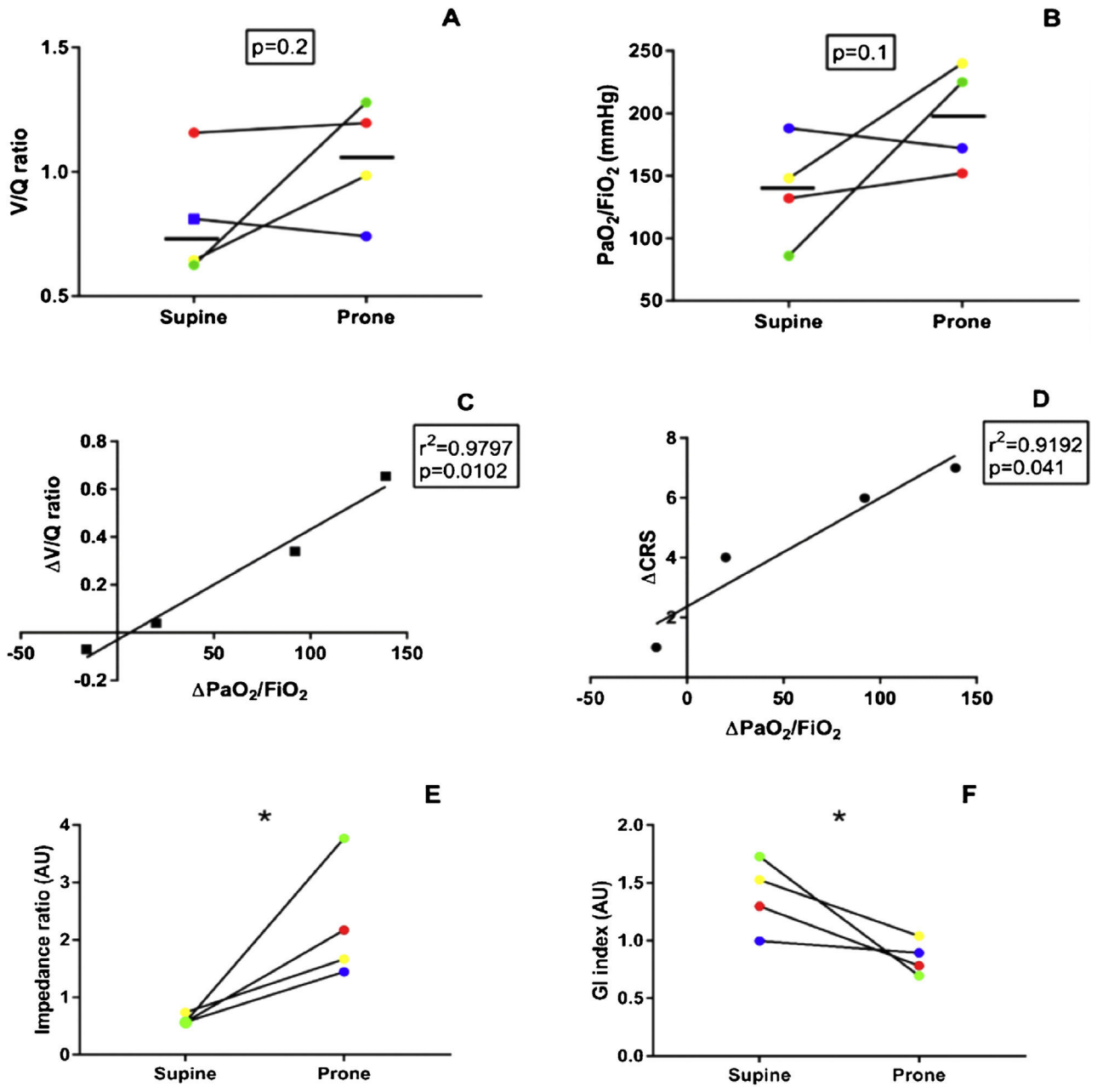

Figure 2 Individual changes in dorsal ventilation/perfusion ratios (V/Q, A) and oxygenation (PaO_2/F_IO_2, B) and from supine to prone positioning in the dorsal lung regions. Relationships between changes in PaO_2/F_IO_2 and V/Q ratios of the dorsal lung regions are represented in C and between changes in PaO_2/F_IO_2 and the C_{RS} in panel D. A different color represents each patient. Changes in EIT indices are shown in E and F. V: ventilation: Q: perfusion; PaO_2: arterial partial pressure of oxygen; F_IO_2: fraction of inspired oxygen, CRS: Respiratory system compliance, GI: global inhomogeneity index, AU: arbitrary units, * = $p < 0.05$.

The PP promoted a significant improvement in oxygenation and lung mechanics, which is in line with previous reports.[8] The improved oxygenation was directly correlated to improvements in the dorsal V/Q ratio (Fig. 2). Improved V/Q could be explained by diversion of ventilation to dorsal lung regions, due to changes in the superimposed pressure gradient[9] in the presence of a dorsal dominance of perfusion. These findings have been previously demonstrated in other settings, such healthy volunteers, and experimental models of lung injury.[10]

In this small series of patients, we observed that PP improved gas exchange and pulmonary mechanics through a change in the distribution of ventilation towards the dorsal regions of the lungs and promoting a more homogeneous ventilation distribution. Analysis of V/Q ratio through EIT could provide bedside, real-time, and individual information on the effectiveness of the prone maneuver and possibly predict tolerance to position changes. New studies with a larger number of patients are necessary to validate these findings.

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Conflicts of interest

Authors declare no conflicts of interest.

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Ventilación mecánica no invasiva u oxigenoterapia de alto flujo en la pandemia de COVID-19: el empate se deshizo

Non-invasive mechanical ventilation or high-flow oxygen therapy in the COVID-19 pandemic: Dead heat broken

Sr. Editor:

Durante la reciente pandemia de la COVID-19, el soporte respiratorio no invasivo ha desempeñado un papel central[1] en el manejo de pacientes con insuficiencia respiratoria hipoxémica aguda.

La mejor opción terapéutica para estos pacientes siempre fue un tema de debate[2]. Frente a la clásica ventilación mecánica no invasiva a base de CPAP o del uso de 2 niveles de presión, la oxigenoterapia administrada mediante cánulas nasales de alto flujo (CNAF) fue ganando popularidad debido, probablemente, a su facilidad de uso, alta tolerabilidad y la posibilidad de aplicación fuera de las UCI[3], cualidades que la hacían muy atractiva en los difíciles primeros días de la pandemia. Sin embargo, la evidencia científica que respaldaba su uso se antojaba insuficiente[4]. Ello motivó nuestra anterior carta, en la que reivindicábamos, al menos temporalmente, un empate para la disputa planteada entre ambos soportes respiratorios no invasivos.

En nuestra opinión, la evidencia generada por el estudio RECOVERY-RS[5] ha desplazado el equilibrio en favor de la ventilación mecánica no invasiva (VMNI). Utilizando de nuevo el símil deportivo, «aunque haya sido durante la prórroga, el empate se deshizo».

El estudio RECOVERY-RS se realizó entre el 6 de abril del 2020 y el 3 de mayo del 2021 en 48 hospitales en el Reino Unido y Jersey. Los pacientes se asignaron al azar para recibir CPAP (n = 380), oxígeno nasal de alto flujo (n = 418) u oxigenoterapia convencional (n = 475). Para maximizar el rendimiento dadas las duras condiciones de la pandemia, el diseño es un poco especial. Se trata en realidad de 2 ensayos clínicos aleatorizados paralelos que comparten grupo control: en los hospitales que solo disponían de VMNI los pacientes se distribuían al azar para recibir CPAP u oxigenoterapia convencional, en aquellos que solo disponían de CNAF, la aleatorización se realizaba entre CNAF y oxigenoterapia convencional y en los que disponían de los 3 soportes, la distribución aleatoria se hacía entre los 3 grupos. La variable de resultado principal es un compuesto de intubación traqueal o mortalidad dentro de los 30 días. De los 1.273 pacientes analizados la necesidad de intubación traqueal o la mortalidad dentro de los 30 días fue significativamente menor con CPAP (137/377 = 36,3%) que con frente