RESEARCH ARTICLE

Correlation of Oxygen Index, Oxygen Saturation Index, and PaO_2/FiO_2 Ratio in Invasive Mechanically Ventilated Adults

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Abstract

Background: With the oxygen saturation index (OSI) being a noninvasive surrogate for oxygen index (OI) and P/F ratio, examining the correlation between PaO_2/FiO_2 (P/F ratio), OI, and OSI in mechanically ventilated adults will benefit in those settings where arterial blood gas monitoring is not readily accessible.

Materials and methods: Data were collected for patients ≥18 years who were under invasive (endotracheal intubation) mechanical ventilation at medical or surgical wards in a tertiary care hospital.

Results: After natural log transformation, the correlations between P/F ratio and OI ($r = -0.94$) and OI and OSI ($r = 0.82$) were strong, but weaker between P/F ratio and OSI ($r = -0.69$).

Conclusion: Future bigger studies are needed to evaluate whether monitoring OSI and/or OI over P/F ratio will impact treatment outcomes.

Keywords: Invasive mechanical ventilation, Oxygenation index, Oxygen saturation index, PaO_2/FiO_2 ratio.

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Introduction

The PaO_2/FiO_2 (P/F) ratio is used to denote severity of lung injury in mechanically ventilated patients. However, the P/F ratio does not reflect mechanical ventilation settings, changes in lung compliance, and pulmonary shunt, the factors that influence the severity of lung injury.[1] The P/F ratio does not account for mean airway pressure (MAP). Mean airway pressure correlates with arterial oxygenation, alveolar ventilation, hemodynamic performance, and barotrauma.[2] These are better accounted for by the oxygenation index ($OI = MAP \times FiO_2 \times 100 \div PaO_2$) and oxygen saturation index ($OSI = MAP \times FiO_2 \div SpO_2$).[3] Additionally, determination of the P/F ratio requires arterial puncture. The OSI can be calculated via the noninvasive pulse oximetry. In pediatric patients, saturation-based measurements identified more patients with acute respiratory distress syndrome (ARDS) than those identified using the arterial blood gas analysis.[4] With OSI being a noninvasive surrogate for OI and P/F ratio, examining the correlation between P/F ratio, OI, and OSI in mechanically ventilated adults will benefit in those settings where arterial blood gas monitoring is not readily accessible.

Materials and Methods

Data were collected for patients ≥18 years who were under invasive (endotracheal intubation) mechanical ventilation at medical or surgical wards in a tertiary care hospital. Only patients with reliable pulse oximetry and SpO_2 measurements were included. To get better SpO_2 measurements, SpO_2 was noted after at least a minute of good pulse oximetry trace, ensuring a clean sensor with fitting sensor position. FiO_2, MAP, and SpO_2 were recorded at the time of daily arterial blood gas sampling (PaO_2). The OI and OSI were calculated based on these measures.

Statistical Analysis

Linear mixed effect models were used to estimate the correlation coefficients between repeated measures of P/F ratio and OI, P/F ratio and OI, and OI and OSI using PROC MIXED in SAS 9.4.

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Results

A total of 203 measurements for 70 patients were collected over a maximum of 11 days after mechanical ventilation (day 1). Mean age was 60.4 years [standard deviation (SD) 14.0] and 62.9% ($n = 44$) were males. About 44.3% ($n = 31$) patients were ventilated for a postoperative reason. On day 1 of mechanical ventilation, 44.3% ($n = 31$) and 24.3% ($n = 17$) of patients had a P/F ratio <300 and <200, respectively, and 15.7, 20, 18.6, 20, 20, and 5.7% of patients had a SAPS II scores of 0–29, 30–40, 41–52, 53–64, 65–77, and ≥78. Mean P/F ratio, OSI, and OI were 345.92 (SD 148.51), 0.061 (SD 0.042), and 4.88 (SD 5.22) over 203 observations, respectively. The relationships between these measures were nonlinear. After natural log transformation, the correlations between P/F ratio and OI ($r = -0.94$) (Fig. 1) and OI and OSI ($r = 0.82$) were strong (Fig. 2), but weaker between P/F ratio and OSI ($r = -0.69$) (Fig. 3).

Discussion

Repeated blood draws for arterial blood gas monitoring add to the risk of phlebotomy-related iatrogenic anemia, risk infections, and add to the costs of care. The primary outcome of interest was to

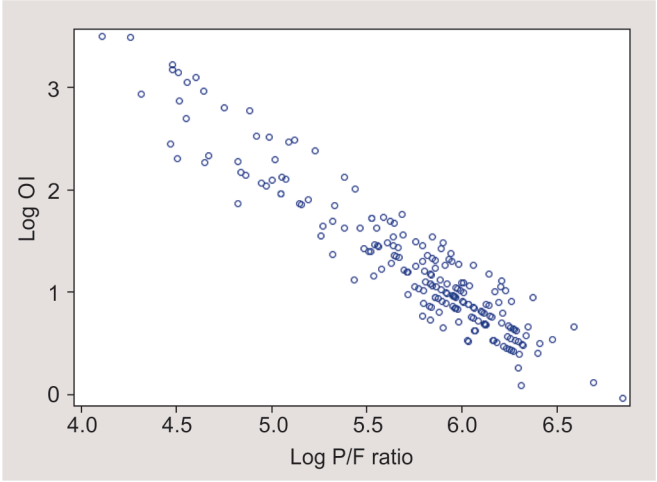

Fig. 1: Scatterplot showing ln(P/F ratio) and ln(OI) for 203 observations. The axes for P/F ratio and OI are on the natural logarithmic scale

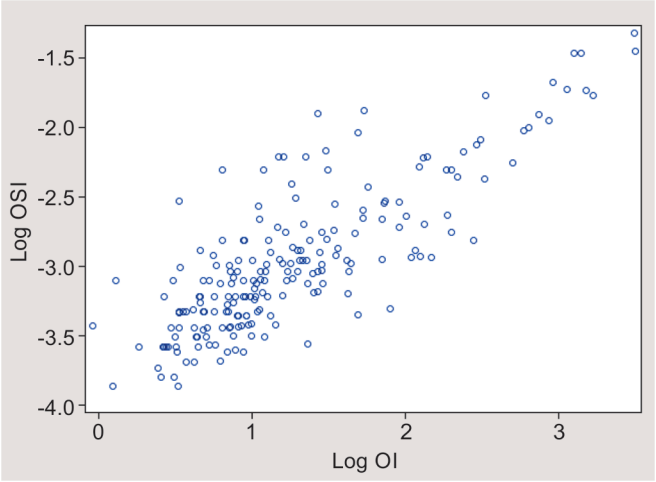

Fig. 2: Scatterplot showing ln(OI) and ln(OSI) for 203 observations. The axes for OI and OSI are on the natural logarithmic scale

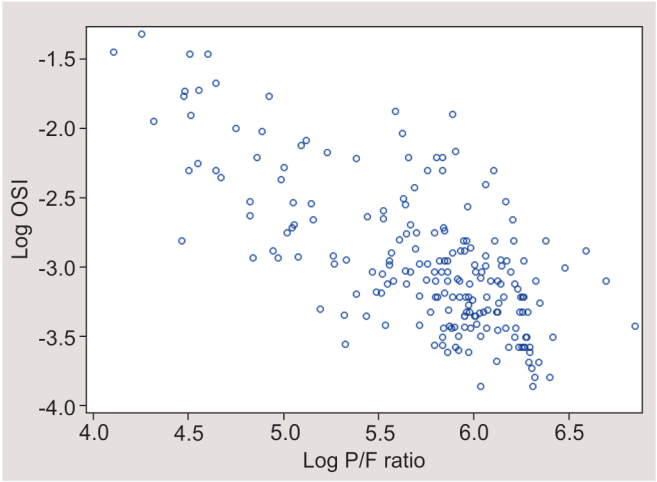

Fig. 3: Scatterplot showing ln(P/F ratio) and ln(OSI) for all 203 observations. The axes for P/F ratio and OSI are on the natural logarithmic scale

find a correlation between P/F ratio, OI, and OSI in order to employ OSI as a monitoring parameter especially in resource-limited areas to reflect the oxygenation status in mechanically ventilated patients. A strong correlation was noted between P/F ratio and OI and OI and OSI in the study cohort. Mechanical ventilation influences the oxygenation for delivered FiO_2. The OI and OSI are consequently an indicator for oxygenation in these individuals. Thus, the noninvasively monitored SpO_2 can be considered a good surrogate to PaO_2 in monitoring continuously the mechanically ventilated, when deemed clinically applicable. The strong point in using OSI is that it includes measurements of MAP, which signals changes in lung compliance, aggressiveness of respiratory support, and oxygenation deficit, thus offering a better approximation of the extent of acute lung injury (ALI).[5] A higher SAPS II score reflects a sick cohort studied. Prognostic values of OI and OSI were not looked at in this study.

Conclusion

There was strong correlation between P/F ratio and OI and also OI and OSI measurements among adults under invasive mechanical ventilation. Future bigger studies are needed to evaluate whether monitoring OSI and/or OI over P/F ratio will impact treatment outcomes.

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