Effects of positive end-expiratory pressure on brain oxygenation, systemic oxygen cascade and metabolism in acute brain injured patients: a pilot physiological cross-sectional study

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Patients with acute brain injury (ABI) often require the application of positive end-expiratory pressure (PEEP) to optimize mechanical ventilation and systemic oxygenation. However, the effect of PEEP on cerebral function and metabolism is unclear. The primary aim of this study was to evaluate the effects of PEEP augmentation test (from 5 to 15 cmH2O) on brain oxygenation, systemic oxygen cascade and metabolism in ABI patients. Secondary aims include to determine whether changes in regional cerebral oxygenation are reflected by changes in oxygenation cascade and metabolism, and to assess the correlation between brain oxygenation and mechanical ventilation settings. Single center, pilot cross-sectional observational study in an Academic Hospital. Inclusion criteria were: adult (> 18 y/o) patients with ABI and stable intracranial pressure, available gas exchange and indirect calorimetry (IC) monitoring. Cerebral oxygenation was monitored with near-infrared spectroscopy (NIRS) and different derived parameters were collected: variation (Δ) in oxy (O2)-hemoglobin (Hb) (ΔO2Hbi), deoxy-Hb(ΔHHbi), total-Hb(ΔcHbi), and total regional oxygenation (ΔrSO2). Oxygen cascade and metabolism were monitored with arterial/venous blood gas analysis [arterial partial pressure of oxygen (PaO2), arterial saturation of oxygen (SaO2), oxygen delivery (DO2), and lactate], and IC [energy expenditure (REE), respiratory quotient (RQ), oxygen consumption (VO2), and carbon dioxide production (VCO2)]. Data were measured at PEEP 5 cmH2O and 15 cmH2O and expressed as delta (Δ) values. Ten patients with ABI [median age 70 (IQR 62–75) years, 6 (60%) were male, median Glasgow Coma Scale at ICU admission 5.5 (IQR 3–8)] were included. PEEP augmentation from 5 to 15 cmH2O did not affect cerebral oxygenation, systemic oxygen cascade parameters, and metabolism. The arterial component of cerebral oxygenation was significantly correlated with DO2 (ΔO2HBi, rho = 0.717, p = 0.037). ΔrSO2 (rho = 0.727, p = 0.032), ΔcHbi (rho = 0.797, p = 0.013), and ΔHHBi (rho = 0.816, p = 0.009) were significantly correlated with SaO2, but not ΔO2Hbi. ΔrSO2 was significantly correlated with VCO2 (rho = 0.681, p = 0.049). No correlation between brain oxygenation and ventilatory parameters was found. PEEP augmentation test did not affect cerebral and systemic oxygenation or metabolism. Changes in cerebral oxygenation significantly correlated with DO2, SaO2, and VCO2. Cerebral oxygen monitoring could be considered for individualization of mechanical ventilation setting in ABI patients without high or instable intracranial pressure.