Effects on cerebral blood flow of position changes, hyperoxia, CO2 partial pressure variations and the Valsalva manoeuvre: A study in healthy volunteers

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Abstract
BACKGROUND: Maintaining adequate blood pressure to ensure proper cerebral blood flow (CBF) during surgery is challenging. Induced mild hypotension, sitting position or unavoidable intra-operative circumstances such as haemorrhage, added to variations in carbon dioxide and oxygen tensions, may influence perfusion. Several of these circumstances may coincide and it is unclear how these may affect CBF. OBJECTIVE: To describe the variation in transcranial Doppler and regional cerebral oxygen saturation (rSO2), as a surrogate of CBF, after cardiac preload and gravitational positional changes. DESIGN: Observational study. SETTING: Operating room at Hospital Clínic de Barcelona. VOLUNTEERS: Ten healthy volunteers, white, both sexes. INTERVENTIONS: Measurements were performed in the supine, sitting and standing positions during hyperoxia, hypocapnia and hypercapnia protocols and after a Valsalva manoeuvre. MAIN OUTCOME MEASURES: Cardiac index (CI), haemodynamic and respiratory variables, maximal and mean velocities (Vmax, Vmean) (transcranial Doppler) and rSO2 were acquired. Results were analysed using a generalised estimating equation technique. RESULTS: CI increases more than 16% after a preload challenge were not accompanied by differences in rSO2 or Vmax-Vmean. With positional changes, Vmean decreased more than 7% (P=0.042) from the supine to the seated position. Hyperoxia induced a cerebral rSO2 increase more than 6% (P=0.0001) with decreases in Vmax, Vmean and CI values more than 3% (P=0.001, 0.022 and 0.001) in the supine and standing position. During hypocapnia, CI rose more than 20% from supine to seated and standing (P=0.0001) with a 4.5% decrease in cerebral rSO2 (P=0.001) and a decrease of Vmax-Vmean more than 24% in all positions (P=0.001). Hypercapnia increased cerebral rSO2 more than 17% (P=0.001), Vmax-Vmean more than 30% (P=0.001) with no changes in CI. After a Valsalva manoeuvre, rSO2 decreased more than 3% in the right hemisphere in the upright position (P=0.001). Vmax-Vmean decreased more than 10% (P=0.001) with no changes in CI. CONCLUSION: CBF changes in response to cerebral vasoconstriction

and vasodilatation were detected with rSO2 and transcranial Doppler in healthy volunteers during cardiac preload and in different body positions. Acute hypercapnia had a greater effect on recorded brain parameters than hypocapnia.