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Systemic and Cerebral Perfusion in Neurocritical Patients; Any Relationship?

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ABSTRACT

This article has no abstract.

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[1] Microcirculatory perfusion during different perioperative hemodynamic strategies [2] Oxygen extraction and perfusion markers in severe sepsis and septic shock: diagnostic, therapeutic and outcome implications [3] Impact of increased mean arterial pressure on skin microcirculatory oxygenation in vasopressor-requiring septic patients: An interventional study [4] Impact of intravenous fluid challenge infusion time on macrocirculation and endothelial glycocalyx in surgical and critically Ill patients [5] An investigation of cerebral oxygen utilization, blood flow and cognition in healthy aging [6] Brain Oxygenation Monitoring [7] In a search of pressure which optimizes autoregulation of cerebral blood flow [8] Feasibility of improving cerebral autoregulation in acute intracerebral hemorrhage (BREATHE-ICH) study: Results from an experimental interventional study [9] Effect of a resuscitation strategy targeting peripheral perfusion status vs serum lactate levels on 28-day mortality among patients with septic shock: A bayesian reanalysis of the andromeda-shock trial [10] Prognostic implications of microcirculatory perfusion versus macrocirculatory perfusion in cardiogenic shock: A culprit-shock substudy

The word perfusion is etymologically derived from the Latin perfundĕre, which means spread. Perfusion is a continuous and regulated physiological process of blood volume distribution per unit of time and weight of tissue to guarantee energy requirements (nutrients and oxygen). To this end, a complex transport network includes lungs, heart, red blood cells/hemoglobin, microvasculature, and microvasculature that work strictly regulated to receive oxygen from the environment and transport it to the cells [1, 2].

Traditionally, perfusion was evaluated by monitoring systemic variables (macrocirculation), which constituted a limitation given its regional character with heterogeneous distribution according to the particular needs of the different regions of the organism through a microvascular network (microcirculation) [3, 4]. In the case of the human brain, which represents 2% of body weight, given its energy need, it uses 15% of cardiac output, 25% of glucose, and 20% of oxygen consumption of the entire organism. Approximately 50% of oxygen and 10% of arterial blood glucose that reaches through a cerebral blood flow (CBF) of 50ml/100g/min is used for its metabolism [5, 6]. Under physiological conditions, CBF is coupled to brain metabolism, which is known as metabolic regulation. Maintaining an adequate and constant CBF in the face of changes in cerebral perfusion pressure (CPP) requires compensatory mechanisms such as cerebral auto-regulation [7, 8]. Physicians attending critical patients should direct their actions to achieve adequate perfusion. To achieve this goal, the first step is to monitor the perfusion to be able to define whether it is suitable for the patient's needs. Even with monitoring systemic perfusion with both macro and microcirculation variables, it is necessary to incorporate specific regional or organic variables that will allow diagnosing and acting in abnormal situations [9, 10]. By way of illustration of the previous statements, preliminary data are shared on a series of neurocritical cases that were monitored for systemic perfusion variables and cerebral perfusion variables through transcranial Doppler ultrasound and oxygen saturation at the jugular bulb level (V_d: diastolic velocity; V_m: mean velocity by transcranial Doppler ultrasound; CEO_2: cerebral oxygen extraction; MAP: mean arterial pressure; SvO_2: central venous oxygen saturation; $AVDCO_2$: venous; arterial difference of CO_2).

In the entire series, 52.4% of patients had some element of systemic hypoperfusion; 63.3% of them showed normal cerebral perfusion at the same time of monitoring. Moreover, in that group of normal cerebral perfusion, 61.5% showed CBF decoupling pattern/metabolism compatible with luxury cerebral perfusion or hyperemia. Even 18.2% of patients with cerebral hypoperfusion patterns, according to transcranial Doppler ultrasound, showed a pattern of hyperemia through the monitoring of cerebral oxygen extraction, and therefore, the CBF was above the needs according to real brain metabolism. Computerized tomography of the skull, cerebral oxygen extraction (CEO_2) was 20%, and transcranial Doppler ultrasound with diastolic velocity was 19.3cm/s, mean velocity was 30.8cm/s in the middle cerebral artery. The transcranial Doppler pattern was compatible with cerebral hypoperfusion; however, the CEO_2 study suggested relative hyperemia.

Systemic perfusion monitoring through macro- and microcirculation variables and monitoring of dependent organ variables is necessary to establish an accurate diagnosis of the patient's situation and, especially, to direct therapeutic actions. The peculiar characteristics of cerebral perfusion make CBF monitoring, along with cerebral metabolic monitoring, mandatory.

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