Anesthesia overrides carbon dioxide in regulating cerebrospinal fluid flow, finds study

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A recent study on the effects of commonly used anesthetic and sedative drugs on cerebrospinal fluid flow and volume has uncovered significant findings regarding their impact on the brain's vital glymphatic system.

These findings may affect neuroanesthesia practices.

Researchers at the University of Helsinki, University of Copenhagen, and University of Rochester found that two commonly used anesthetic regimens are stronger in regulating cerebrospinal fluid flow and cerebral blood volume than the influence of blood carbon dioxide.

This finding may reshape neuroanesthesia practices in clinical settings, particularly in neurological, brain trauma, and neurosurgical scenarios, where manipulating carbon dioxide levels is routine for regulating cerebral blood flow, cerebral oxygenation, and intracranial pressure in intubated patients.

The work is published in the journal *Anesthesiology*.

"The findings of this study, which showed that the assessed anesthetics blunt the vasomotor responses and cerebrospinal fluid flow effects of carbon dioxide, can influence the choice of anesthetics used in a variety of clinical situations and potentially improve clinical practices.

"Most importantly, it is vital to know how anesthetics influence the fluid compartments within the brain. Similar studies are required in humans," says Associate Professor, MD Tuomas Lilius from the University of Helsinki and Helsinki University Hospital.

Using a rat model, the researchers found that ketamine–dexmedetomidine anesthesia increased perivascular space size and consequently increased cerebrospinal fluid flow. This was uninfluenced by supplemental inhaled carbon dioxide, which is a well-known dilator of cerebral blood vessels.

The findings implicate that cerebrospinal fluid flow through the brain could be preserved, maintaining brain clearance through the glymphatic system. Further, administration of the inhaled anesthetic isoflurane increased cerebral blood vessel diameters and consequently decreased cerebrospinal fluid flow and volume.

"Should our findings apply to humans, our research could impact the choice of anesthesia used for neurosurgical or neurological patients. Our research suggests that dexmedetomidine could be used to overcome the influence of blood carbon dioxide levels on cerebrospinal fluid flow and blood volume in scenarios where carbon dioxide accumulates.

"The cerebral effects of high carbon dioxide can be detrimental for patients with elevated intracranial pressure," says Terhi Lohela, researcher and anesthesiologist from the University of Helsinki and Helsinki University Hospital.

"The effect of the anesthetics was so strong that it overcame the influence of carbon dioxide. This is surprising," concludes the first author and Ph.D. researcher Daniel Persson.

More information: Niklas Daniel Åke Persson et al, Anesthesia Blunts Carbon Dioxide Effects on Glymphatic Cerebrospinal Fluid Dynamics in Mechanically Ventilated Rats, *Anesthesiology* (2024). DOI: 10.1097/ALN.0000000000005039

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