Blood-brain barrier changes in high altitude

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Cerebral syndromes related to high-altitude exposure are becoming more frequent as the number of trips to high altitudes has increased in the last decade. The commonest symptom is headache, followed by acute mountain sickness (AMS) and high-altitude cerebral edema (HACE), which can be fatal. The pathophysiology of these syndromes is not fully understood. The classical "tight-fit hypothesis" posits that there are some anatomical variations that would obstruct the sinovenous outflow and worsen vasogenic edema and intracranial hypertension reactive to hypoxia. This could explain microhemorrhages seen in autopsies. However, recent magnetic resonance imaging studies have demonstrated some components of cytotoxic edema in HACE absent in AMS, suggesting a dysfunction in water balance at the cellular level. Currently, the "red-ox theory" supports trigemino-vascular system activation by free radicals formed after hypoxia and the consequent oxidative stress cascades. Apart from trigemino-vascular system activation, free radicals can also provoke membrane destabilisation mediated by lipid peroxidation, inflammation, and local hypoxia inducible factor-1? and vascular endothelial growth factor activation, resulting in gross blood-brain barrier (BBB) dysfunction. Besides alterations in endothelial cells such as increased pinocytotic vesicles and disassembly of interendothelial tight junction proteins, capillary permeability may also increase with subsequent swelling of astrocyte end-feet. In conclusion, although the pathophysiology of AMS and HACE is not completely understood, recent evidence proposes a multifactorial entity, with brain swelling and compromise of the BBB considered to play an important role. A fuller comprehension of these processes is crucial to reduce and prevent BBB alterations during high-altitude exposure.

Acute mountain sickness

Blood-brain barrier

Brain microvessels

Endothelial cells

High altitude cephalea

High altitude cerebral edema

Hypobaric hypoxia

altitude

animal

blood brain barrier

human

injuries

metabolism

pathology

Altitude

Animals

Blood-Brain Barrier

Humans